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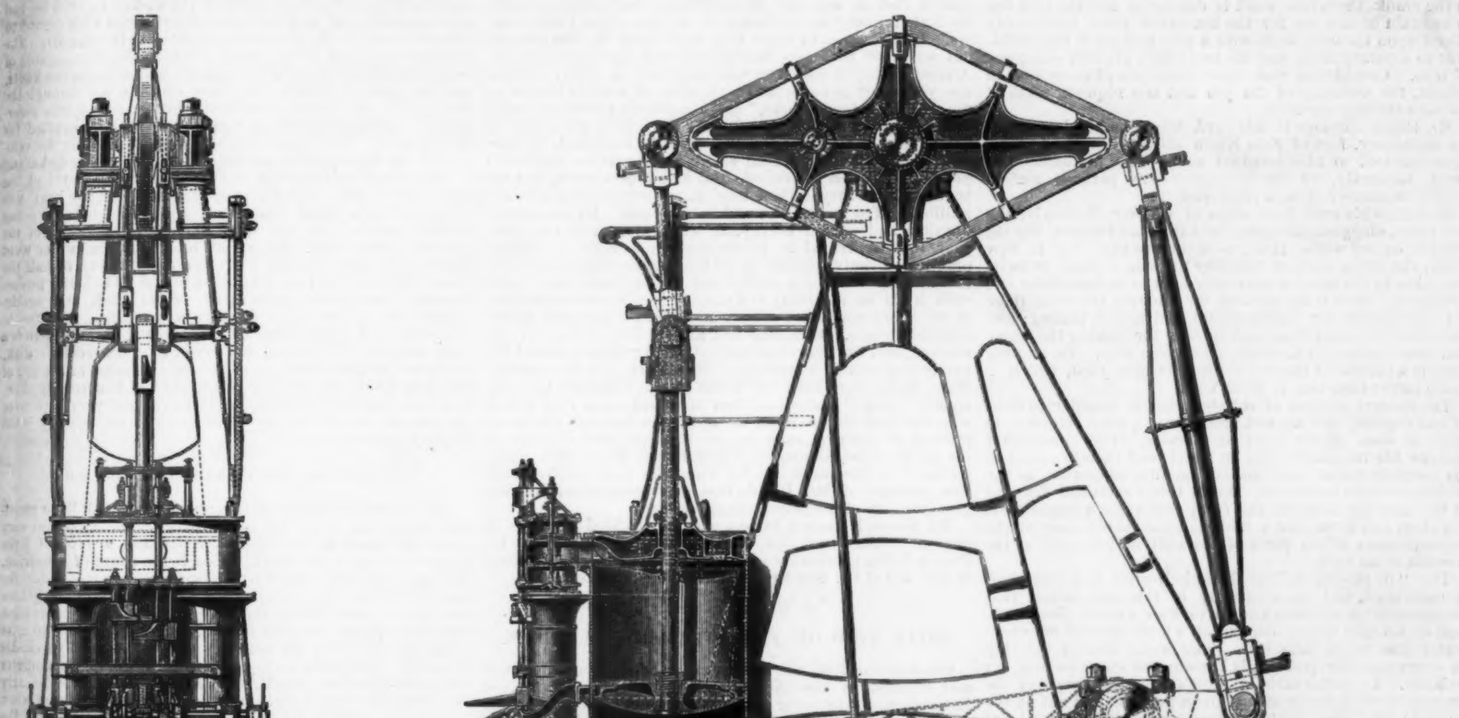
THE NEW STEAMER PILGRIM.

WE illustrate below the engine of the steamship Pilgrim, lately constructed for the Old Colony Steamboat Company by Messrs. John Roach & Son, New York and Chester, Pa. The boilers of the Pilgrim are to carry a pressure of 50 lb. per square inch, and will be tested probably for a limit of 80 lb. They will be twelve in number, of steel, arranged in four batteries, of a pattern which is described as being in use in some of the North River towing steamers. The boat itself is 374 feet long and 50 feet beam; width over guards, 86 feet 6 inches; depth of hold, 18 feet 6 inches; draught of water, about 11 feet; measurement, say 3,500 tons. The cylinder, which is expected to develop 6,500 horse power, is 110 inches diameter and 14 feet stroke; piston rod, 12 inches diameter; beam pin, 18 inches diameter; center to center of beam, nearly 29 feet; weight, 33 tons; connecting rod, finished weight over 12 tons. The details of valve gear are of the regular type, consisting of double beat poppet valves counterbalanced by a lever weight for inlet and exhaust, worked by cams on a rock-shaft operated by the eccentric. The frame is of wrought iron, and shows a considerable advance on the old wooden framing, which, however, has done such good service in many American boats, the elasticity of which renders necessary a frame capable of withstanding the variations in alignment of its supports. The engraving of the engine is from the *Engineer*. All the other illustrations and the following particulars are from the SCIENTIFIC AMERICAN.

The Pilgrim, now in process of construction by Mr. John Roach for the Fall River Line, is the largest steamboat ever built. The company required the most commodious steamer, with the highest power and speed attainable, and this will in a few months be completed and delivered by the builder. Our engravings on the third page illustrate the forging of the shaft, one with the end in the furnace for the "finishing heat," and the other "under the hammer."

This shaft is the largest ever constructed. And it must be borne in mind that the illustration represents only the half shaft. The other half is to be connected with it amidship by the crank, and is, of course, of the same length. Each measures 29 feet 6 inches in length, and is 28¼ inches at its largest, and 26 inches at its smallest diameter, and weigh each 81,200 pounds. This enormous shaft implies the size of the engine, and also the size and power of the boat, though in respect to the stability and speed of the latter, other conditions are to be considered of which we will make mention hereafter. In considering this statement, many will think of large side-wheel steamers, including the Great Eastern, but they must also remember that each of her wheels is driven by a separate engine, which calls for a smaller shaft, as it does for a smaller engine, while in this case, one engine drives both wheels, and is intended to do so at the highest speed and attainable power. Hence the necessity of a large piece of machinery. It is said, without fear of contradiction, that no other shop in this country could turn out such an engine, or forge a shaft of such magnitude. The capacity of a forge for such work depends upon the power of the steam hammer, and this one, though perhaps not the largest, has proved equal to turning out the largest piece of work yet produced. The hammer itself weighs not less than seventeen thousand pounds, and in its fall, driven down by steam power, represents a blow of not less than sixty-six thousand pounds. But certain it is that, in this case, a mass of iron at a forging heat, three feet in thickness, was pounded into shape. The anvil and block rest on a massive foundation, and this on a foundation of piles, in all some twenty to thirty feet deep, and the force of the blow is felt in the ground at a distance of several blocks. The method of working the steam hammer is illustrated in the engraving.

The process of forging was not different from that in somewhat smaller work, but, of course, called for the exercise of special skill, in consequence of the peculiar difficulty of the task. To begin at near the beginning, "blooms" are prepared from "scrap iron." This "scrap iron" consists of an endless variety of wrought iron scraps, such as horse shoes, bolts, rods, nails, boiler iron, etc., etc. These are in the blacksmith shop welded together under a small steam hammer into bars, somewhat of the shape of bars of pig iron. The iron thus prepared is better for this purpose than any other, being tough and fibrous, and the product is known as a "bloom." In building the shaft begins with the "porter bar," on the end of which are piled the "blooms" for that heat. This "porter bar" is designed only for the purpose of carrying the first "blooms" into the furnace for a welding heat, and carrying them out again under the hammer. But inasmuch as it becomes incorporated in the shaft in part, it is carefully weighed, as are the "blooms," to ascertain how much material is used in the work. Afterward the shaft grows to a length sufficient to carry the blooms for its increasing length.



ENGINES OF THE NEW IRON STEAMER PILGRIM—JOHN ROACH & SON BUILDERS.

The process of hammering naturally increases the length of the mass of iron while it is being reduced to its proper thickness, and this increased length is hammered into two flat surfaces above and below, known as a "scarf." On this "scarf" for the next heating are piled from fifteen to twenty blooms, which are carried into the furnace, brought to a welding heat, and then put under the hammer, and welded into one mass. The shaft is turned over and a new supply of blooms piled upon the opposite side of the "scarf." These are then carried into the furnace, brought to a welding heat, put under the hammer, and welded. After another heating this whole mass is rounded into the desired size and shape. And so the process goes on of piling on the blooms, heating, forging, shaping, building up the scarf, and piling on more blooms. And the shaft goes on increasing in length. To do this work on each half shaft required about fourteen days' constant work. And to handle the shaft in heating and shaping required a gang of upwards of twenty men. This is, of course, apart from the work of preparing blooms, tending the furnaces, running the crane engines, handling material, the extent and cost of which are perhaps only known to the members of the firm and the book-keeper

of the works. After each half shaft is completed in the forge it is taken into the shop and then turned. This turning is done as perfectly and as neatly as if the iron, 39 feet 6 inches long, and not far from one yard in thickness, were intended for a gold watch. The machinery, appliances, and skill for such work are too well known to require description.

What is implied by the size of the shaft is carried out in all parts of the engine. The cylinder is 9 feet 2 inches in interior diameter, with 14 feet stroke, and was cast in the same works. The working beam from center to center is 29 feet long, by 14 feet 6 inches across, and weighs 38 tons. The paddle wheels are 14 feet in diameter.

These figures alone will convey a just appreciation of the magnitude of the work. The entire engine in all its material, casting, forging, turning, and putting together, was done in this shop. Needless to say the building is not large enough for the setting up the entire engine, and consequently the separate parts can alone be fitted, and after proper adjustment and numbering, removed. The niceness of the work done may be further illustrated by recalling the circumstance that we have witnessed the putting together a shaft and crank piece, an operation requiring so great promptitude and accuracy that the slightest or smallest error will, in a few minutes, destroy thousands of dollars' worth of material. The crank is bored something like an eighth of an inch less in diameter than the diameter of the shaft. To admit of inserting the shaft the crank has to be heated sufficiently to expand the metal until the bore is of the same size with the shaft. Then the shaft, which has been kept at a uniform temperature, is inserted. If this is done too slowly, or the shaft does not go home to its proper place, or, from irregular turning, is not true in its bearing to the crank, the whole work is destroyed, and the iron has to be again broken up, for the hot crank piece has already closed upon the cold shaft with a grip making it impossible ever to separate them, and the two pieces are now one piece of iron. Considering that these pieces are of many tons in weight, the difficulty of the job and the requisite skill of the men become apparent.

Mr. Roach employs in this yard, where he builds most of his machinery, foot of East Ninth street, New York, from eight hundred to nine hundred men. The industries fostered, indirectly, by his enterprise are perhaps tenfold greater in number of men employed.

He builds his great iron ships at Chester, Pennsylvania, and there, alongside the unfinished ironclad Puritan, lies the Pilgrim on her ways. Here, as in the machine shop in New York, the entire work of building the ship is done, from its inception in the mind of the constructor to its launching and fitting up. Here is the furnace for smelting the iron; there the rolling mill for rolling plates and armor plating; and there the forge and shops and furnace for making the frame and iron timbers, so to speak, of an iron ship. On another page is a sketch of the water front of this yard, which is much larger than that in New York.

The general subject of ship-building is familiar to most of our readers, but we will insert here a brief reference to what is done in the yard at Chester. The constructor designs his miniature ship in wood, and therein exercises his peculiar talent and creative faculty, somewhat as the sculptor creates in his art. From this a sectional drawing of the same size is made, and from that again a larger scale drawing, and from that a table is constructed showing the measurements of all parts of the hull in feet and to the fraction of an inch.

The "displacement" of the ship, loaded and unloaded, is calculated, and so accurately is this ascertained that the constructor has been known to draw a chalk line on the hull of his ship before launching which showed her exact water line when launched. The water line of the ship in every possible position is known, and consequently her stability. From the table of proportions the shape of the cross sections or frame at any given point is laid out on the "mould loft" floor with great accuracy, in the actual size of the ship to be built. And from this wooden patterns are made to correspond with every part of the frame. These patterns are now in turn placed upon an iron floor, covered all over with square holes intended to receive iron pins, and its curvature accurately marked in and out among the holes, which are then supplied with pins and bolts. The angle iron intended for that particular rib or part of the frame is brought from the furnace at a red heat, and after being drawn into this curved line, is bolted down until it cools into permanent shape. Two are made alike, corresponding for the opposite sides of the ship; so of every part of the frame from stem to stern. The iron plates are rolled in the mill, with equal care, into the required curvature for each part of the ship, sharp or gradual as to the position required. Each plate has its number and place to which it is brought ready shapen to be laid in place, where and when alone it can be placed, and then riveted to the frame.

The drawing room of this yard presents to the visitor perhaps a more perfect idea of the extent of the works than any other part. It has the appearance almost of an art gallery of marine subjects. Every object the eye rests upon is a reminder of ships. The walls are covered with pictures and models of every form of ocean steamer, steamboat, and yacht built or now building, these models beautifully executed, while the cases are filled with working drawings of every part of the ship, finished in the most elaborate manner. The party for whom the ship is to be built indicates generally what is to be her carrying capacity, and possibly expresses some fancy as to her lines, but beyond this the constructor designs the ship, whether as to practical considerations or matters of fancy.

On another page we give a sketch of the City of Peking, the largest ship yet built by Mr. Roach, turned out of this yard, and of a design in construction which has been largely followed, and has received very general commendation. There are in process of building here six or more iron ships, designed for foreign trade, the work as well done as can be produced in any shipyard of the world. The United States ironclad, Puritan, lies on the stocks in an unfinished condition. It seems incomprehensible that the Government should leave so magnificent a ship in an unfinished condition for so many years. Near by, on the stocks, and almost complete, is the Pilgrim. She is built with a double hull, that is, two iron hulls, one somewhat smaller and inside the other, braced together. This gives increased strength on the principle of the tubular bridge, and safety in case of injury to the outer hull. Her length over all is 390 feet, 87 feet beam outside the guards amidship, and 12 feet draught, with a proposed speed of twenty miles an hour. The American ensign, presumably in proportion, is to be 30 x 20 feet. She appears on the stocks like an iron mountain, and that, too, without saloons or deck houses. As the shaft implies the engine, so the work turned out implies the magnitude of the works, the capital, skill, and enterprise of its organizer, as well as the labor, skill, and materials utilized. The average number of laborers in this yard is 1,800 to 3,000.

During the past ten years the firm of John Roach & Sons has built and delivered over one hundred iron steamers. That is to say, ten per year on an average, that is, one in a little over a month each—building the ship and the machinery; these representing contracts with the South American States, Spain, and our own people.

Ship building in Chester was practically unknown until Mr. Roach established his yard there, some ten years since. And now, as we have said, he finds employment for 1,800 to 3,000 men, with all that is incidental to such employment for the benefit of a place.

The story of the career of this man, who is the father of American iron ship building, has that simplicity which attaches to the lives of most eminent men, an oft told tale, but in his case one of almost unparalleled success. He commenced business life as a boy in the foundry of the Allaire Iron Works, in New-York, as a moulder, at a time when the best workmen received a precarious compensation of one dollar per day, and it may be easily conjectured what a poor boy must have received. He there learned his trade, passing through the daily experience of young men in that capacity.

Subsequently, when he had acquired sufficient knowledge and saved up sufficient capital, say, fifty dollars, he established a foundry of his own, "ridiculously small," as some one has said. But it grew, though at first no one would have believed it to be a foundry, until it became to be the celebrated "Etna Iron Works." Commencing with small castings, the contracts grew to large castings, then a machine shop, and boiler shop. During his early days it is not recorded that he was one of the strikers, but after he started his little foundry he continued to be one of the hard workers. It is pleasant to know that since then he has bought out some of the tools, machinery, and appliances of the Allaire works, in which he was employed as a boy. About the year 1868 he came into occupation of what is known as the "Morgan Iron Works," and about 1872 purchased most of his property at Chester. It has often been predicted by companies, in his line of business, that he must fail, because one man *could not* succeed where a corporation could not prosper and often has failed. But he has prospered, and the beginner with fifty dollars now has a property representing millions. The secret lies within the man. Extraordinary physical and mental energy, at work night and day from year to year, frugal in habits and democratic in feeling, practical, strictly reliable in all his engagements, he is a representative man of a thrifty and enterprising age. And with it all he is kindly and charitable. No one complains of his being rough and coarse, and many can testify to his considerateness. One who has known him for years remarked, and the figures prove it, "If Mr. Roach should die to-day it would be a *calamity* to New York and to Chester." Many things have been said about him in reference to "monopoly" and "protection," but it would seem that a man who has been able to build up as he has builded, and to represent an industry such as this is, is qualified to judge of the needs of the country in ship-building, and to give "protection" to the hundreds for whom he finds employment. The portrait of Mr. Roach that accompanies our sketches gives an idea of his personal appearance.

Mr. Roach is known to be a man of decided opinions in respect to the promotion of American industries, and his ideas relating thereto are presented in a special article printed in No. 340 of the SCIENTIFIC AMERICAN SUPPLEMENT.

TRIAL TRIP OF THE STEAMSHIP ZAANDAM.

ON July the 20th, the iron screw steamer Zaandam, built and engined by the Netherland Steamboat Company, of Rotterdam, to the order of the Netherland American Steam Navigation Company, left the Fyenoord yard for Amsterdam. The principal dimensions are: Length, 328 feet; breadth, 39 feet; load draught, 23 feet 8 inches; gross register tonnage, 3,070 tons; net ditto, 2,282 tons. The engines are inverted compound surface condensing, 43 inch and 76 inch cylinder diameters, and 4 feet stroke; 70 lb. pressure of steam. The ship was ordered some fourteen months ago, and launched in the beginning of May. She was got along the quay and under the crane for putting her machinery in on May 24. The trial trip along the coast from Maassluis to Ymuiden gave very satisfactory results. A company of about thirty gentlemen witnessed the trial, and Mr. Van der Hoeven, as director of the Netherland American Steam Navigation Company, said, in a speech at luncheon, that the Zaandam was another good acquisition to their fleet of nine steamers running from Amsterdam and Rotterdam to New York. We may mention that two of these have been built and engined at the Fyenoord works of the Netherland Steamboat Company, viz., the Leerdam for their Rotterdam-New York line, and the Zaandam for their Amsterdam-New York line. The Zaandam arrived at New York August 23, on her first voyage, which was very successful.

SCREW PROPULSION.

A LECTURE on screw propulsion was delivered in London by Mr. Robert Griffiths, inventor and patentee of the Griffiths screw, on the evening of the 15th April. The lecturer began by saying that although during the half century that has elapsed since the propulsion of ships by the screw propeller was regarded as little more than an experiment, and during which its use has gradually extended until it has become the only means by which ocean ships are propelled, numerous patents have been taken out for so-called "improvements in screw propellers," very little real improvement has been effected, notwithstanding the large amount of attention which the subject has received. Possibly this is to a great extent due to the prevalence of erroneous ideas respecting the loss of power which occurs, for one of the chief difficulties in the way of effecting improvements has been the uncertainty of how the loss was occasioned, and hence, while endless attempts were being made to discover the best form for the screw, the position of the screw with respect to the hull of the ship, which is by far the most important factor in the result, was overlooked. Until recently the slip of the screw was regarded as the measure of the loss of power that had occurred. From the time of the lecturer's earliest acquaintance with the subject he held this theory to be wrong, and indeed proved its fallacy on H. M. S. Flying Fish in 1856. The screw with which she was then fitted gave an unsatisfactory result, as it showed more than 20 per cent. of slip. Mr. Griffiths was ordered to make a propeller, which was to be of gun metal, and he offered to supply a pair of experimental blades of cast iron, guaranteed to give negative slip, though the speed would not be increased in consequence. The offer was accepted, and the cast iron blades were made from the same pattern as the others, the only difference being that the shanks were put at an angle, so that when the blades were inserted in the boss they inclined toward the ship. When his screw had been tried, and gave a favorable speed compared with the previous screw, though showing some 15 per cent. positive slip, the blades were inserted, and were found to propel the ship with 6 per cent. negative slip, though the speed was not so satisfactory. Though this clearly proved that the slip by no means indicated the efficiency, or rather the inefficiency, of the propeller, it was of little assistance in helping to ascertain what became of the power that was applied to the propeller.

That the power actually necessary to propel a ship was small in proportion to the power which had to be exerted through the screw to do it, he ascertained by some model experiments which he made. These models were fitted with clockwork for driving the screw, and he found that if the clockwork was removed from the boat, and applied to tow it, the trim being kept the same by putting in weight equal to that of the clockwork taken out, it was capable of giving it nearly half as much speed again as when propelling it by means of the screw. This showed that since the power necessary to produce any given speed is proportional to the cube of that speed, the power actually required for propulsion was less than one-third of that which was expended on the screw.

Consider what actually takes place when the screw is working in the ordinary position. Suppose a screw ship were being towed; then of course the water flows through the screw's disk, but the velocity at which it flows varies considerably at different parts of the disk. In 1875 he had an opportunity of making some experiments with regard to this with one of H. M. steam launches at Devonport. The launch was towed at the speed at which she was capable of being propelled by her own engines, which was seven knots, and the speed at which the water was flowing through the disk which the screw described when working was ascertained by apparatus which had been specially applied for the purpose. The experiment showed that while the velocity of the current through the bottom half of the disks, and at the outsides for some distance above the level of the screw shaft, was approximately that at which the boat was being towed, a great falling off was indicated on going higher, until at the top, three inches on each side of the middle of the boat, the speed at which the water went through the disk was only three and a half knots, or half the speed at which the boat was being towed. The screw pushes the ship forward by pushing the water back, and accelerating the currents to a velocity approaching that due to the pitch and revolutions of the screw. Hence there is a very unequal distribution of power over the screw's disk, for most of the power is, of course, expended at the top of the disk where the velocity of the current is naturally slow, and consequently is greatly accelerated, and very little over the bottom part of the screw's disk, where the velocity is but slightly accelerated.

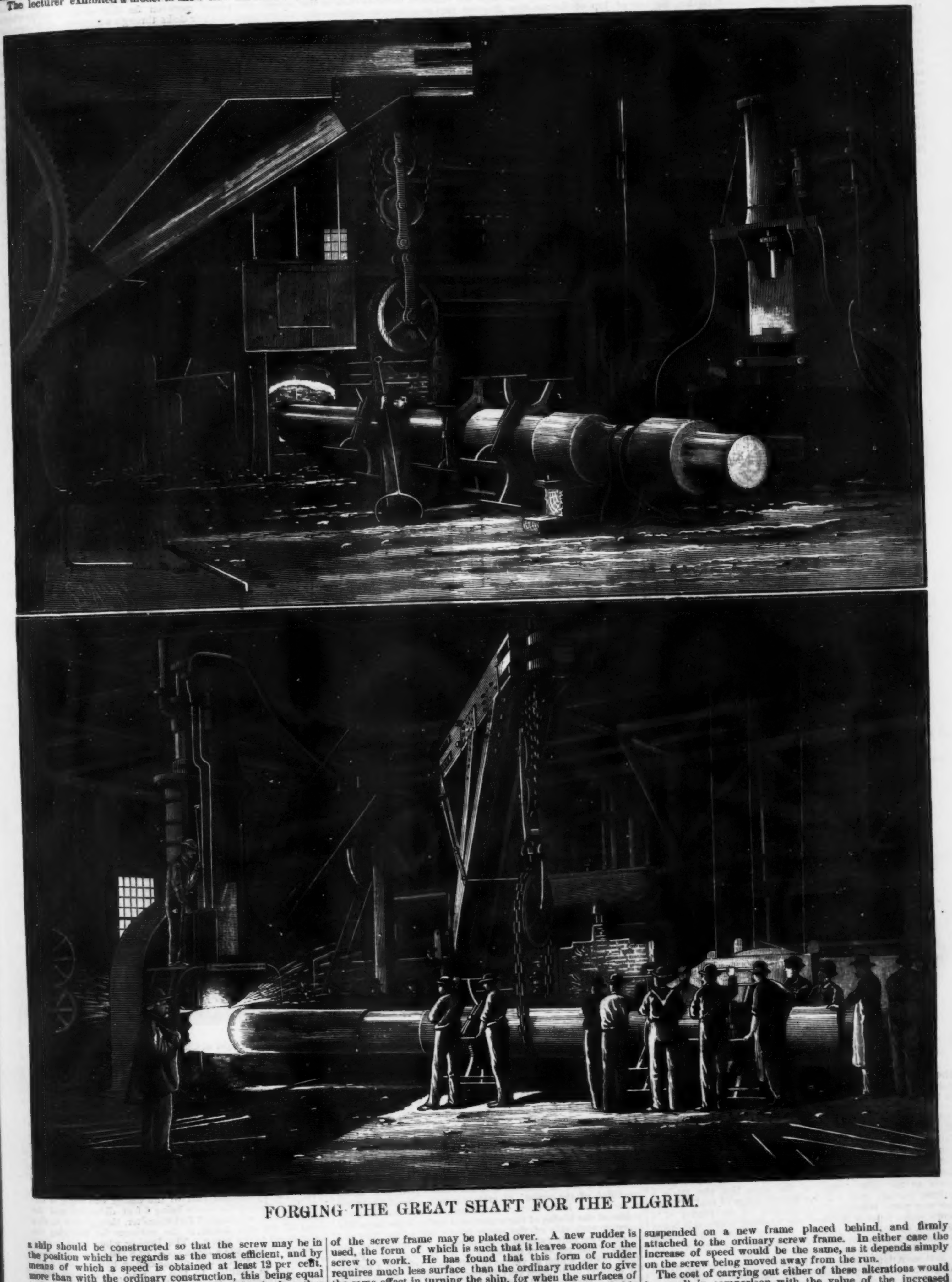
THE CAUSE OF THE VIBRATION OF THE SCREW.

And since the blades of the screw meet with little resistance in passing over the lower part of the disk, but very great resistance as they approach the top, a series of jerks is given to the screw shaft, which is the cause of vibration. He has frequently met with persons who were under the impression that the bottom blade met with more resistance and gave more thrust than the top blade, an impression which is entirely contrary to fact, and which seemed to arise from the idea that the screw was affected by hydrostatic pressure. But this is not the case. The dynamometer diagrams obtained from H. M. S. Rattler showed very clearly the great increase of resistance the blades encountered when they were vertical, for with her two-bladed propeller the thrust was found to vary from 2·9 tons, when the blades were horizontal, to 4·1 tons when vertical; and, as in the latter position, the blade at the bottom could encounter no more resistance than when horizontal, this great increase of thrust must have been entirely due to the extra resistance offered to the top blade. Hence we see that at those parts of the screw's disk where the water is being dragged with the ship, and which are about the top behind the full part of the run, the greater part of the power is exerted, and, dragging away the water, it causes much less pressure to be given to the stern by the closing in of the water than there would otherwise be, and the ship encounters much more resistance in moving forward; for the pressure of the water closing on the stern balances to a great extent the pressure on the bow, so that if this pressure on the stern is reduced, greater force is necessary to move the ship forward. In the Admiralty model experiments, conducted by the late Mr. Froude, a model was towed and its resistance ascertained; then the screw was worked behind the model in a frame quite independent of the boat, and it was found that the towing resistance of the boat was increased 40 per cent. The experiment was repeated with the models of several successful merchant ships, and with those the increase of resistance caused by the screw was very nearly as much. The enormous suction that the screw is capable of causing was shown by a working model which was exhibited some four or five years ago at the Royal United Service Institution. This was fitted with a telescopic pipe, which led from a compartment inside the vessel, and could be pushed out close to the screw. The water would, it was found, flow in by gravity through this pipe and fill the compartment in ten seconds; but if the pipe was pushed out to the screw, the screw when propelling would cause such a suction that it would empty the compartment in eight seconds, a loss of only 19 per cent. of speed being occasioned while the operation was going on. The long course of experiments which he carried out on working models enabled him to ascertain that whenever a screw was working, as in existing ships, within a short distance of the wedge of the stern, it caused the water to close with very much less pressure on that part of the wedge, and in consequence considerably more thrust was necessary to cause the ship to move forward than would otherwise be required.

He then tried the effect of moving the screw away from the wedge of the stern, and found that when the screw was placed further aft more speed was obtained, and that the speed increased as the screw was moved aft until it was placed two-thirds of its diameter from the ends of the wedge of the run. With the screw in this position a maximum speed was obtained of at least 12 per cent., and in some cases as much as 15 per cent., more than with the ordinary arrangement. Again, when the screw was moved further aft than this, the speed fell off gradually. The increase of speed was owing to the screw retarding the vessel less as it

was moved away from the tapered surface of the hull; but when it had been moved more than two-thirds of its diameter it got behind the place where the currents from each side met, and as the flowing together of these currents offers considerable resistance to the screw, a falling off in the thrust takes place if it is fixed further aft than this, and its efficiency is reduced.

The lecturer exhibited a model to show how the stern of and also by a diagram. The screw is removed from the screw-frame, and the rudder-post having been cut, a bearing is inserted in it. The screw shaft is lengthened either by putting a short piece between the couplings inside the ship or by welding a piece on the end so as to pass right through the bearing in the rudder-post. This brings the screw about the right distance from the end of the run, and for affording additional strength to the rudder post the bottom part angle that the other was. Another advantage connected with this form is that when the screw is not working the rudder is able to steer the ship efficiently. The difficulty of steering many screw ships under the same conditions is well known, and has led in cases of machinery breaking down to disastrous results. He has another arrangement, the essential difference compared with the former one being that the ordinary rudder is used, it being



FORGING THE GREAT SHAFT FOR THE PILGRIM.

a ship should be constructed so that the screw may be in the position which he regards as the most efficient, and by means of which a speed is obtained at least 12 per cent. more than with the ordinary construction, this being equal to increasing the power 40 per cent. Vibration is altogether prevented, and the steering much improved by this arrangement. A way by which existing ships may be altered so as to obtain these advantages was shown by a second model, of the screw frame may be plated over. A new rudder is used, the form of which is such that it leaves room for the screw to work. He has found that this form of rudder requires much less surface than the ordinary rudder to give the same effect in turning the ship, for when the surfaces of the two rudders were of the same area, the rudder of this form would turn the boat equally as fast, and in the same space, though put over only a little more than half the suspended on a new frame placed behind, and firmly attached to the ordinary screw frame. In either case the increase of speed would be the same, as it depends simply on the screw being moved away from the run.

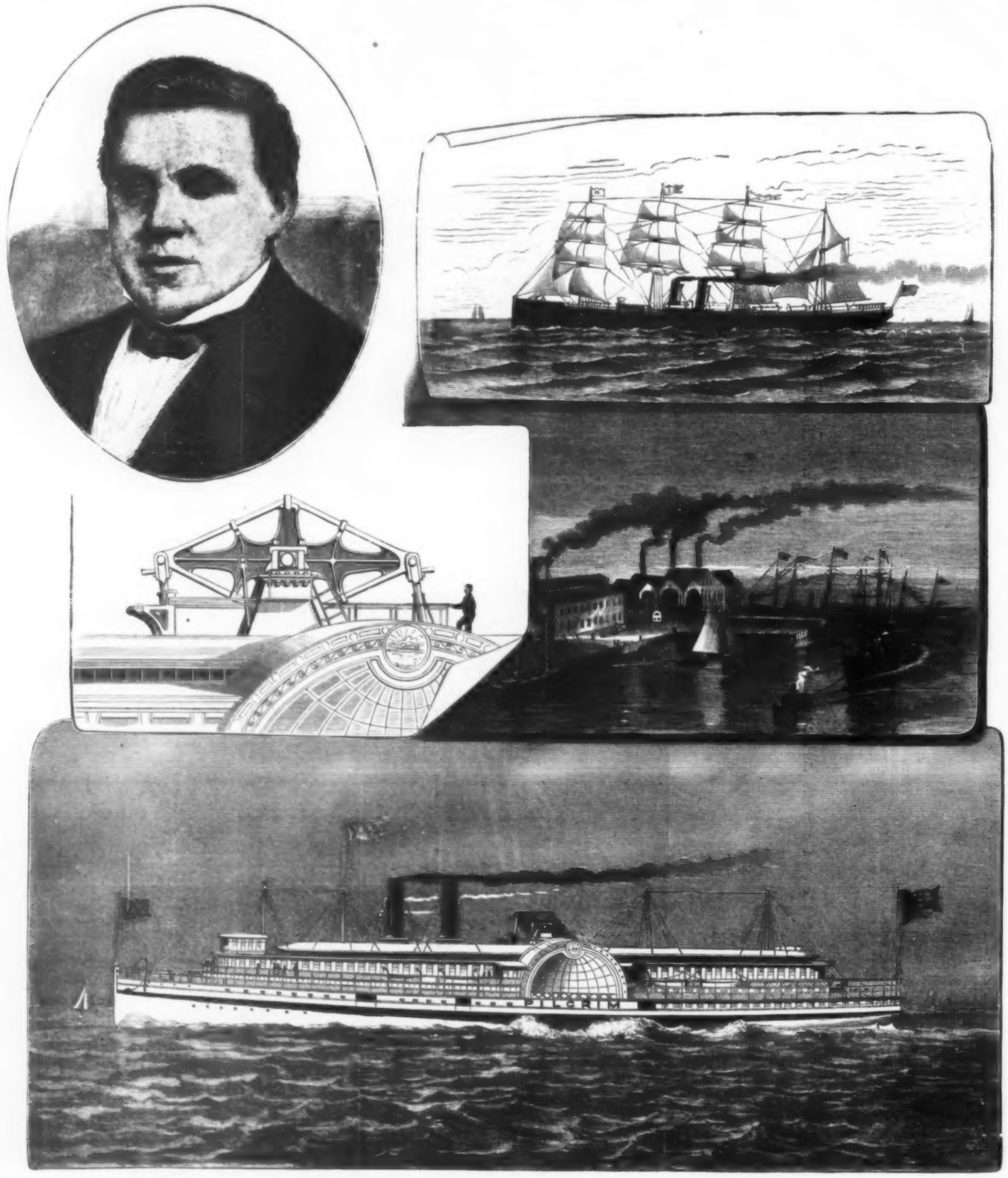
The cost of carrying out either of these alterations would be small in comparison with the value of the increased speed that would result. To take a rough estimate, to increase the speed of a ship 12 per cent. requires the engine

power to be increased 40 per cent. Now, taking the value of marine engines at £45 per nominal horse-power for the first cost, the coal required for their consumption, the space occupied in the ship by the coal, the cost of repairs, etc., would, at a very moderate calculation, amount to a similar sum, so that an increase of 12 per cent. in the speed of a ship would be equivalent to an increase in the value of the ship of £3,600 for every 100 nominal horse-power of the engines that are in her; and, compared to this, the cost of the alteration becomes insignificant. The lecturer also exhibited a diagram showing a screw propeller which can be applied to ordinary ships without any alteration being required. This screw comes close to the rudder-post, and he states that with an ordinary width of screw frame the substitution of a screw of this form for an ordinary screw gives an increase of 5 to 8 per cent., or about half the advantage of the complete alteration. Several screws like this have been made, and have given a highly satisfactory result in each of the cases in which they have been applied. The ships that have already been fitted with them are the Retriever, Elephant, Great Northern, John Pender, and a small steamer at Penang, and one has been made for the Mercedes, but has not yet been put on. In the cases of the Retriever and the Elephant a knot and half a knot were gained respectively. Measured mile trials were not made in the other cases. In addition to the increase of speed in each case there was a decided improvement in steering and the vibration was much reduced. In building the Adjutant, Messrs. Barclay, Curle & Co. adopted the system more fully by making the screw frame considerably wider than usual, and placing the screw close to the rudder-post; but the only comparison that could be made in this case was that in her first voyage out, carrying half as much cargo again as the other vessels of the same line, she made a quicker passage with a lesser consumption of coal. When the enormous resistance encountered by the blades of a screw when passing through the retarded currents is borne in mind, considerable light is thrown upon some results which have been obtained recently from screw ships by reducing the diameter of the screw propeller.

In three Atlantic steamers, the particulars respecting which are given in the paper read by Mr. Maginnis at the Institution of Naval Architects, new propellers, smaller in diameter than their original screws by 2 feet 6 inches in two cases and 1 foot 4 inches in the other, were fitted, and a gain in speed of a half, a third, and a half of a knot per hour respectively resulted, with a considerable saving of coal on the voyage. This advantage was entirely due to the smaller screws acting less on retarded water at the top of the disk. But the most conclusive proof was given by H. M. S. Iris, which was fitted with 18 feet 6 inches diameter four-bladed screws, the blades having wide points; and the resistance encountered by these in their passage through the retarded currents close to the top of the run was so great that considerable negative slip resulted, in consequence of which the currents would press on the back of the blades at the outside of the disk, and neutralize part of the thrust, causing an unsatisfactory speed to be obtained; for when the ship was fitted with four-bladed Griffiths screws 16 feet 3 inches diameter, and afterward with two-bladed Griffiths screws 18 feet 1½ inches diameter, which, owing to their narrower points, would experience much less resistance there, a gain of nearly two knots in speed resulted, the slip increasing to 5 per cent. positive.

The lecturer then drew attention to what he claimed to be an exceedingly simple and inexpensive plan of preventing the waste of power explained in the earlier part of the lecture, namely, the loss caused at the top part of the screw's disk by most of the power being exerted there on the retarded currents, the dragging back of which increases the ship's resistance so enormously. Models showing the application of the apparatus to a single screw, and to twin screws, were exhibited. The single screw model consists of two plates attached to the top part of the screw frame. These plates form part of cylindrical surfaces, the upper one being at a distance equal to about one-twelfth the diameter of the screw from the points of the blades, the surface extending in the fore and aft line from some distance in front of the screw to the rudder-post, and about one-third of the screw's diameter on each side of the screw frame. The lower surface comes as close as possible to the points of the blades of the screw, and extends the same distance on each side of the screw frame, but in the fore and aft direction only extends from opposite the middle of the points of the blades of the screw to the rudder-post. From these plates, which as yet have only been tried in a model, the lecturer anticipates very favorable results. So far they showed a very marked influence in increasing the current of water through the top of the screw's disk, and this leads to the vessel being less retarded by the action of the screw, the evil being diminished not simply in proportion to the increase in the velocity of the current, but, owing to the more equal distribution of power over the screw's disk, in a very much higher ratio. In fact, the experiment showed, though it might seem incredible, that this apparatus increases the speed of a ship 7 to 8 per cent. The apparatus for twin screws is similar, the only difference being that the plates in this case, instead of being over the tops of the screws, are placed more on the sides next the ship, which is the part of their disks through which retarded currents pass.

With regard to the protection of the screw propeller from being fouled and injured by ropes, wreckage, or floating substances, the officers of the Royal Navy are fully aware of the liability of ships becoming disabled, and are most anxious that steps should be taken to prevent what, in all probability, will prove a most fruitful source of disaster whenever a naval engagement occurs. The application of a cylindrical cover over the screw propeller has been proposed at various times, but has invariably, when tested, caused a very considerable loss of speed, and the problem remained in this condition until the lecturer made some experiments in 1873 and 1874, by which he ascertained that the loss had resulted from the screw being unable, under those circumstances, to obtain sufficient water to act upon. For overcoming this defect he tried the application of an enlarged entrance or funnel mouth which should gather in water into the cylindrical part of the casing. This led to a much better speed being realized, the casing then increasing the speed slightly, except when the screw was unusually large in proportion to the ship. These results having been brought before the Admiralty, the Lords determined to try a casing of this form on H. M. gunboat Bruiser in 1875. The cylindrical part of the casing was made 6 feet 1 inch diameter, the screw being 6 feet diameter, and the funnel mouth was made 7 feet diameter, thus giving an area about 35 per cent. larger at the entrance for allowing the water to get to the screw. The Bruiser when tried on the measured mile made a mean speed of 8·280 knots, the speed previous to the application of the casing having been 8·016 knots; and, in addition to this increase, there were other decided advantages, for the vibration was very much reduced, and the vessel answered her helm much more quickly. It was found, too, during some heavy weather that she encountered in the Channel, that the screw had no tendency to race when the vessel was pitching. To obtain additional



John Roach. Walking-beam of the Pilgrim. The Pilgrim. The Peking. Shipyard at Chester, Pa.

SHIP-BUILDING WORKS OF JOHN ROACH & SONS.

proof of the advantage in speed, the Lords of the Admiralty afterward ordered two more trials to be made with the casing and two without, and these fully confirmed the first results. Though this casing gave a decided advantage, Mr. Griffiths has since found that it was not by any means the best form that could have been used, for the experiments that he has since made have shown that a screw draws in water opposite the forward part of the periphery for about half the width of the points of the blades, and opposite the after half drives it out. If this driving-out action is prevented, which can be done by fixing a cylindrical ring over that part, more resistance is offered by the water to the propeller, and more thrust is obtained; but if the drawing in action of the front part of the periphery is prevented, the whole of the suction of the screw is concentrated on the stern of the ship. This increases the ship's resistance very much. Hence it is necessary that the casing, if it is to extend farther forward than the middle of the points of the blades of the screw, should be enlarged there.

One of the models in the lecture hall was fitted with a casing over the screw which, while giving most complete protection to the propeller, is better suited for speed than the one which was applied to the Bruiser. This casing consists of two cylindrical rings, one, which is just large enough for the screw to work in, extending from the middle of the propeller to the rudder post; and the other, which is about one-eighth larger in diameter, is attached by suitable fastenings, so that its after edge overlaps somewhat the forward edge of the small ring. By this arrangement, though the screw is completely covered, the drawing-in action of the forward part of the periphery of the screw is in no way checked, and should the forward ring take in more water than the screw requires, the excess can pass between the rings without causing a resistance to the forward movement of the ship. Radial bars can be fixed in the forward ring so as to reach from the run to the outside of the casing at a convenient angle for turning off floating substances, which would otherwise enter and foul the propeller, and the casing may be stiffened by fixing struts between the rudder-post and the small ring at the after end. The screws of some steam trawlers now being built for the National Fishery Company will be protected in this manner; but when it becomes generally known that by this arrangement the screw can be protected without loss of speed, which will be proved by those boats, it will be well worth the consideration of shipowners whether the safety resulting from its application would not render it worth while for all ships to be fitted with it.

[Continued from SUPPLEMENT 347, page 5530.]

THE PANAMA CANAL ACCORDING TO THE SURVEYS OF MESSRS. WYSE AND RECLUS.

By MANUEL EISSLER, M.E., of San Francisco, Cal.

V.

LINE OF THE CANAL.

THE different surveys and explorations made prove that the Isthmus of Panama offers four routes for a sea level canal passing through the following valleys:

1st. Chagres, Caño Quebrado, Congo, and Caimito.
2d. Chagres, Caño Quebrado, Bonito, Paja, Bernardino and Caimito.
3d. Chagres, Mandingo, Potrero Caimito.
4th. Chagres, Obispo, and Rio Grande.

When we turn from these lines to the East or West we find no more chances to cross the isthmus, as its width increases very rapidly, and more compact mountain chains are interposed between the Atlantic and Pacific.

Of these four lines the last named is certainly the best; it follows for a long distance the valley of the Chagres, which is the lowest, the widest, and less sinuous than those of the Caño Quebrado and its affluents.

The pass of Culebra, being the lowest of the isthmus, is this line or tracé which requires the least cutting; this line near its termini approaches the depths of eight meters in the bays; it is also the tracé which requires the least submarine work, and another great and important point—it has the railroad right alongside, which in such an immense undertaking is of great help.

In looking at the map accompanying this tracé, it will be seen that the valley of the Chagres is not sufficiently wide to allow the canal to be built there on either shore of this river, and at the same time to limit the amount of earth and rock to be excavated to 75,000,000 cubic meters; it therefore became necessary that the line of the canal should be so fixed as not to conform at all with the course and meanderings of the river.

The line which Messrs. Wyse and Reclus proposed will give the minimum of rock and earth extraction, and fulfill the following conditions:

1. The radius of the curves will never be less than 3,000 meters.

2. The great cut through Culebra will be in a perfectly straight line, but at the entrances on both sides to this cut, the line leaves at the heads of the cut and between the first points of the adjoining curves, a length of axis in a straight line, sufficient to facilitate the entrance to and exit from this cut, which means that the curves on both sides do not immediately commence on leaving the straight cut.

3. The line of the axis of the canal will have to be laid out in such a way as not to cut the line of the railroad in but few points, but at the same time keeping as near to it as possible, in such a manner as to avoid the difficult and costly modifications to the actual trace of the canal line, and so as to facilitate the execution of the work by keeping as close as possible to the railroad.

This last condition is fulfilled to perfection, as the canal will cross the railroad but once at San Pablo. At that point it will be necessary to establish a turning bridge, since the railroad and canal cross each other between two hills which are close together, and are composed of solid trachytic rocks, these offering a solid base for the turning pivots of the bridge.

The canal commences in the Bay of Limon with a depth of 9 meters at a point nearest to the land. The entrance is protected by the Island of Manzanilla from the N. N. E. winds, which are the most troublesome.

The coast currents which run to N. E. enter the Bay of Limon up to this point, and will remove from the mouth of the canal the alluvium and earth which might deposit there, build up a bar, and diminish the depth of the anchorage ground.

Although the waters of the Chagres carry but little alluvium even during the floods of the rainy season, a bar of some magnitude would have been formed, as well as a delta at its mouth, were it not for these coast currents.

Analogous deposits to those that exist at the mouth of the Chagres will probably also take place at the entrance of the canal, namely, a small accumulation of heavy sands; and all that will be required, like at the Suez Canal, will be to occasionally use a dredge to clear away these deposits when they become embarrassing. This work will offer no difficulties during the greater portion of the year, as the Bay of Limon is quiet, without heavy swells or turbulent seas.

From the entrance on the Atlantic side up to a distance of 1,280 meters, the axis of the canal will be in a straight line.

From that point a curve will take place to the right 5 kilometers in radius, having an angle of curvature of 30°, and 3,180 meters in length, avoiding the small hills with which the marshes of Mindi are studded, and at the same time the line of the railroad. For about 1 kilometer the canal takes the bed of the Rio Mindi.

At the 5th kilometer, the canal meets a little hill 4 meters high, the extremity of the hills of the Loma de Mindi.

At a distance of 6,620 meters commences a curve to the left, with a radius of 3,500 meters, 44°, and 2,600 meters long, which enables the canal to avoid the hills near the station of Gatun and the hill of Loma del Tigre. In this section the canal crosses the Chagres twice. A cross section established here shows that the canal passes through the bottom slope of the detached hills of the high Cerro Gatun.

At 13,250 meters commences a curve to the left of 5,000 meters radius, 41° 5', and 3,580 meters long, crossing the Chagres three times in this distance.

At 19,440 meters commences a curve to the left of 3,500 meters radius, 43°, and 2,600 meters long. This curve has for object to throw as much as possible the axis of the canal to the north without cutting the railroad, so that the canal can cross the bend of Buhio Soldado, by cutting through its least elevated point, which rises up south of the river.

At 22,040 meters commences a curve to the right of 3,000 meters radius, 38° 45', and 2,020 meters long, tangent to the railroad at Buena Vista; the canal thus avoids the cutting through of the abrupt hills which rise at this point on both sides of the Chagres. These last two curves cross the Chagres five times.

In coming out of this pass, one of the most delicate points of the tracé, the line enters into the plain of Frijole.

At 25,420 meters commences a curve to the right of 3,500 meters radius, 60°, and 3,655 meters long, cutting through the hill of Varro Colorado.

At 29,075 meters commences a curve to the left of 81° 15', and 4,945 meters long, which goes through the large plain extending between Frijole and Tabernilla, and for a distance of 300 meters will take the bed of the Chagres; this curve has a radius of 3,500 meters.

At 34,875 meters commences a curve to the left of 39° 30', and 2,065 meters long, having a radius of 3,000 meters; this curve will cut the railroad, the Chagres, and through the hills which descend from the Cerro Taylor. The altitudes of these crests are from 35 to 45 meters above sea level. The canal then again enters into the valley proper of the Chagres.

At 36,940 meters commences a curve to the right of 40° 10', 2,100 meters long, having a radius of 3,000 meters, and for a length of 600 meters will take the bed of the Chagres.

From 39,040 meters to 43,045 meters the axis of the canal crosses the Chagres five times.

At 43,045 meters commences a curve to the right of 3,000 meters radius, having 62° 30', 3,260 meters long; this curve crosses the Chagres for the last time, and enters the valley of the Obispo.

At 46,305 meters commences a curve to the left of 3,500 meters radius, having 17° 30', and 915 meters length, which leads to the entrance of the great cut.

This cut of the Culebra is in an absolutely straight line, 7,720 meters long, and leads into the valley of the Rio Grande.:

At 55,000 meters commences a curve to the left of 3,000 meters radius, having 29° 15' angle of curvature, and is 1,530 meters long.

At 56,530 meters commences a curve to the right of 3000 meters radius, having an angle of 18°15', and is 1,530 meters long.

From 57,495 to 60,095 meters, the axis of the canal is in a straight line. Then commences a curve to the right of 5,000 meters radius, having an angle of 47°15', and 4,140 meters long.

From 68,515 to 73,200 meters, the extremity of the canal, the axis is in a straight line.

The canal's outlet on the Pacific is to the east of the anchorage grounds of the islands Naos and Perico, where the water is 7 meters deep, and the surface of the basin about 30 hectares, thus making a harbor sufficiently large to accommodate all ships which may navigate through the canal at any time; ships of deeper draught will have to lie to a little outside, 6 to 7 cable lengths to the southeast.

FORM AND DIMENSIONS OF THE CANAL.

(The Basin of the Canal.)

At the outlet of the two oceans the canal will be 100 meters wide at the bottom. This width will gradually diminish up to the seashore, where it will only be 22 meters wide, keeping this width the whole length of the isthmus, with the exception of he stations.

In the ocean, the slope of the submerged banks will be two of base for one of height.

In the earth, alluviums, corals, and movable grounds, the canal will be 50 meters wide on the average sea level, so that the slopes (talus) will be .5 meters base for 8½ meters height at the entrances. On the Atlantic side the canal will keep this width to the 22d kilometer, and on the Pacific side from the 62d kilometer to the Pacific Ocean.

From the 22d to the 62d kilometer, the canal being dug in trachytes, dolerites, and basalts and their tufas, it will be 28 meters wide, average sea level; and for this length the submerged bank will descend with a slope of 3 meters base to a depth of 6½ meters below mean sea level; then from this depth it will slope down a little more perpendicular to the edge of the bottom.

Above sea level the banks of the canal will have 1 of base for 1 of height in earth, and 1 of base for 10 of height in rock.

The height of ground to be cut through above sea level does not permit the digging of a canal sufficiently wide, so that ships could pass one another at all points of the line. It would be necessary to do this to triple the section of the basin of the canal, making the work of extraction of rock and dirt too enormous.

Like at Suez, it is therefore advisable to be content with such dimensions as will allow one ship to go through with security, the crossing of ships from opposite directions taking place in stations.

The bottom of the Suez Canal is 22 meters wide, the same dimension as the Panama Canal. At the water line in the narrow sections the Suez Canal is 58 meters wide, whereas in the Interoceanic Canal the same will be 50 meters in earth and 28 meters in rock.

From experience gained in the Suez Canal, the dimensions are found sufficient for a canal with a single passage. The width at the surface need not be considered, as it depends entirely on the nature of the ground; the only important question is the width of the canal below the keel of ships.

For the portions dug in earth, the slope of the submerged bank is the same as the Suez Canal, but the water level will be 8 meters less in width.

In the rock, where the form of the banks conforms to the shape of the amidship part of a vessel, ships 16 meters wide will have a play of 6 meters to the right and left. Such a width is exceptional, and is only reached in large iron-clad ships. A width of 15 meters is usually met with in cruisers and large government transports. The ordinary breadth of large steamships is 13 meters amidship, so that it will leave them from 7 to 8 meters play on each side.

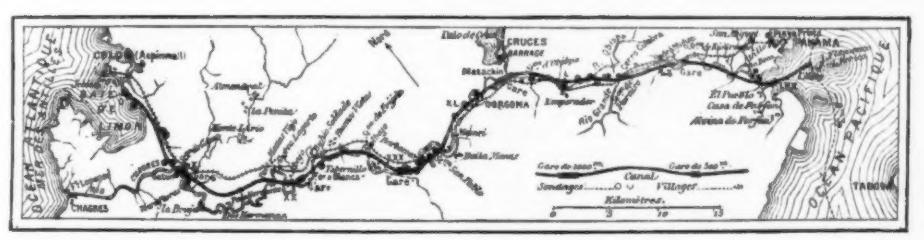
For a ship to get stuck under these favorable conditions, it would be necessary that for some reason or other she should run her bow into one of the banks, and swing her stern around so as to strike the other bank lying then diagonally across the canal. Such a case could never arise except through the utter carelessness and awkwardness of the man at the helm in making a false maneuver. This need not be anticipated, however, as in crossing the canal the company's pilots will take charge of ships.

A very simple reasoning will establish the fact that a ship going through the canal can maintain a normal position without difficulty. When running through the ship has no tendency to deviate from the straight line. The displacement of the ship causes the water to rise forward and pass the sides with increased rapidity, forming as it were a stiff cushion maintaining equal pressure on both sides.

Should the man at the helm through a false maneuver head his ship to the left shore, say 2 meters from the axis, the head would now be 12 meters from the left bank and 16 meters from the right bank, while the stern would be 16 meters from the left and 12 meters from the right bank. The section of escape of water on the left bank increases as we measure from the bow to the stern, and decreases on the right bank correspondingly. We now have an increased pressure on the right bank, and an equally decreased pressure on the left as we go from bow to stern. As in all unequal pressures, the tendency is to equalize themselves; when this is done, the ship will again resume a straight course. Experience has proved this to be a fact in the Suez Canal. Pilots have found that steering is scarcely necessary, the ship naturally keeping in the middle of the channel.

The earth sections of the Panama Canal will be somewhat narrower than at Suez; the facility for maintaining ships in the axis ought therefore to be increased, and as the section decreases in the rock cuts, the tendency of the ships to keep in the true axis ought to be still greater; the comparative narrowness of the Panama Canal as compared with that at Suez will be compensated by the increased safety of transit it will afford.

The radii of the curves in the canal are, as shown before, 3,000 meters upward, and since the radius of the circle of gyration of ships is mostly 300 meters, it will be seen that a very slight variation in the angle of the rudder will allow the ship to follow the curves; under these conditions ships will describe perfect arcs of circles and thus pass without difficulty.



SUBMARINE WORK.

Panama is situated on a high plateau of rocks, which extends quite a distance into the shallow bay, and consequently the bottom of the canal will have to be cut out below water level; this will require considerable submarine blasting.

The valley of the Rio Grande must have been formerly an interior lagoon, which the deposits of the river have gradually filled up.

The entire absence of hills or even little isolated mounds in this flat plain, the direction of the affluents of the Rio Grande and of the Rio Aguacate tributary of the Caimito, in a perpendicular direction to the axis of the valley and parallel to the coast, shows that this valley finds itself inclosed between massive mountains formed by three elevations independent of each other, namely the main chain, the Cerro Cabras, and the Cerro Ancon.

The lagoon formerly connected with the ocean by an outlet which really is now the mouth of the Rio Grande, and the water, as the lagoon filled in, naturally wore a larger channel below these two cerros.

By dredging this outlet, that is, by digging the canal through the mouth of the Rio Grande, it is intended to avoid a great deal of rock cutting; but still this deepening will necessitate a certain amount of submarine work.

JETTIES.

To prevent the mouth of the canal from filling up by shifting sands, it will be necessary to build jetties on both

sides from the mouth of the Rio Grande, as well as at the other end to the extreme points of the canal.

As the currents in the Bay of Panama are not very strong, and as it never storms there, these jetties will not be built very thick, and the slopes will have but a slight incline. All that will be required is platforms 4 meters wide, with slopes of 5 meters base for 4 meters height. The material for the jetties will be brought down from the cuttings of the canal in the rocky portion of the upper Rio Grande, and will be transported in barges to an average distance of about 12 kilometers.

MOTIVE POWER.

As the dam of the Chagres at Gamboa will form a vast reservoir, it is intended to utilize the pressure of water by tapping this basin at some point above the dam, and leading it through flumes or pipes to some localities where the same can be used as a motive power for compressing air for drills, and furnish power to machinery used in the construction of the canal.

STATIONS.

Let us suppose that 40 ships at a time are engaged in passing through the interoceanic canal, 20 going to the Pacific and 20 toward the Atlantic Ocean. Stations would be required having a sufficient length to receive 20 ships, at least a length of 3,000 meters of stations would be required, besides 1,000 meters at least for dredges and other vessels of service, making a total of 4,000 meters.

The stations will have a sufficient width to enable the largest ships afloat to turn out of the axis of the canal.

They will be placed at equal distances and at points which will require the least extraction of rock and dirt; *i. e.*, they will be located in low, even, flat ground.

There will be five stations or slips, as follows:

Station.	Approximate Distance From Colon.	Length of Station.	Width of Station.	Location.
	Miles.	Feet.	Feet.	
No. 1.....	4½	1,640	236	Gatun.
" 2.....	9	1,640	235	Peña Blanca.
" 3.....	20	3,280	236	San Pablo.
" 4.....	28	3,280	223	Matachin.
" 5.....	40	1,640	223	Pedro Miguel.

The width of the last two stations is reduced on account of being built in rock.

RESUMÉ OF THE TRACÉ.

General Remarks as to Construction of the Canal.

As stated heretofore, the line of the canal will empty into the Bay of Limon, and be extended out till it reaches to a distance of 1,200 to 1,500 meters from shore, with a depth of 8½ meters. It will be necessary to do so to dredge the mud and fragments of corals at the bottom of the bay, and also a certain quantity of madreporic rocks, of which several layers are quite thick. It can be stated, however, that the ground in the neighborhood of Colon has but little consistency and is easily worked.

The breakwater, or jetty, at Colon will start from the last wharf, and will be intended mainly for a protection against the north winds and shifting sands. It will extend in a westerly direction, and be built of rocks; a lighthouse will be built at its furthest point. The expense of this jetty is estimated at 10,000,000 francs.

In the marshy lands of Colon the excavators and dredges will do the digging, and no apprehension is felt that the thrown-up embankments of this muddy soil will not hold together and resist the strong rains of the isthmus. M. De Lesseps, in a discussion on the subject, compares this boggy portion of the isthmus to the stretch of country 44 kilometers long at the Lake Menzaleh, on the Suez Isthmus.

The dredges to be used are of the endless chain variety, having large buckets placed at equal distances, raising the dredged materials to a given height, and dumping it into scows or cars, through long inclined planes of pipes of sufficient length to throw wherever required. They are of the same patterns as those used in the Suez Canal, and work similarly to the excavators.

I wish to call attention to another argument of M. De Lesseps. As to the ease with which the canal can be kept from filling in with mud and gravel, and requiring only occasional dredging to keep the same clear, he rightly says that the luxuriant vegetation of the isthmus, where the roots of the enormous trees enter deeply into the soil, forming a perfect underground network, the tendency is to oppose disintegration of the soil.

Observations made lead to belief that his conjectures are correct, as far as the soil which has not been removed is concerned, as nearly all the cuts of the railroad made some twenty-seven years ago show but little wear, and rainfall seems to have but little effect on the soil of the hills, they being covered almost all over with a very sticky reddish clay, very consistent, fatty, and tenacious, resulting from the decomposition of volcanic rocks. In loose earth and clayey ground no difficulty is anticipated from disintegration, as the luxuriant vegetation of which M. De Lesseps speaks can be made use of in covering the embankments. Large clearings of timber and vegetation in those dense forests are required for the surveying operations of the company. These clearings are called trochas.

A clearing, some sixty feet wide, has been made along the whole tracé of the canal, 46 miles in length, during May, June, and July, 1881, by a large force of natives, who chopped down every tree a foot or so above ground, cleared the brush and vegetation, and thus made an opening from Panama to Colon.

As an illustration of the rapid vegetation of the isthmus, I would state that two months later, in September—and this will sound almost incredible, this grand "trocha" was again covered with a miniature forest. In the examinations and trips along the tracé of this trocha the engineers of the canal company always took along with them several natives with long knives, "machetas," to clear away the brush; otherwise it would have been almost an impossibility to pass through; and as it was the period of the heavy rains, the growth was wonderfully rapid. That advantages can be derived from such a vegetation, no one can doubt; this heavy growth can be made available to protect the dug-out earth and clay banks.

The tracé skirts along the shores of the sea to the mouth of the river Mindi, and follows its valley for 3 or 4 kilometers in a south-southwesterly direction, crosses the space which extends between the Sierra Mindi and the Sierra Quebrancha in the middle, to avoid as much as possible the hard gravel stones and conglomerates which are found there in thick layers, should the line approach one or the other of the two Sierras; the canal will then make a slight bend before reaching the Gatun River, where it cuts it in two, and then follows the valley of the Chagres River, and it does not leave it until reaching the station of Matachin.

After reaching the village of Gatun, the tracé of Messrs. Wyse and Reclus goes in a straight line to Palo Harqueta, excepting where it makes a slight deviation to avoid the small hill "Miraflores," and also the elevations of Lion and Tiger hills, both of which are composed of hard rock. In a general way it can be said that, although the canal takes the valley of the Chagres River from Gatun to Palo Harqueta, and passes through the great alluvial deposits of which this valley is formed, yet a certain quantity of hard material to be blasted can be counted upon in this section. The hard trachytic formation of the hills causes large masses to fall into the valley, and rocks may be seen protruding in several places along the banks of the Chagres River.

From Palo Harqueta the canal makes a bend in the other direction, so as to cut only for a short distance through the sandstone grit of Vamos Vamos, which is found on the left bank of the Chagres River, and avoiding at the same time the compact limestone deposit found on the right shore after passing Ahorca Lagarto.

Thus recutting the two great bends or horseshoes of the Chagres, the heads of which are marked by these two localities, the tracé continues across the alluvial plain of Peña Blanca to the narrow pass of Buhio Soldado.

In this third section also a certain amount of compact material can be relied upon, but the engineers think that the first 20 kilometers can easily be dealt with, and that the whole work will be done by dredging machinery and excavators. The work once fairly started these 20 kilometers can be finished in eight months.

It will be necessary in this third section to remain as much as possible within the bed of the river, especially at Buhio Soldado, where we find a solid hill of very hard rock, which furnishes the building material to the railroad company. There is no doubt that although the canal company will try to avoid these rocks, at a certain depth the angle of inclination will bring them into the bed of the canal.

This gorge being passed, we reach a great plain, which extends from the mouth of the Rio Agua Salud to Barbacoas, passing through Frijole and Tabernilla. The different soundings made in this section have demonstrated that between Tabernilla and Barbacoas it will be necessary to remain as near as possible to the river, and that the ground will be principally gravel and sand.

Between Barbacoas and La Gorgona is found the hardest portion of the tracé, excepting the great cut of Culebra. Here a large amount of blasting will have to be done.

From Gorgona to Matachin the valley gets wider; the high banks often expose to view great thicknesses of alluvial deposits; but here and there, especially at La Gorgona and near Matachin, as also in the great bend which the river makes between these two stations, we notice points of hard conglomerates sticking out, and the soundings made there have shown that large layers of hard conglomerates of variable thickness exist.

We now reach the most important portion of the tracé, the passage through the central mass, and the point where the great cut is to be made.

From the foregoing it will be seen that the watershed is nearly parallel to the two oceans, but it is much nearer to the Pacific, and is only some 15 to 18 kilometers distant from the same.

Here at Culebra Hill, whose highest point is 87½ meters, it has been demonstrated that the upper crust of clay and decomposed brecciated volcanic matter attains a depth of about 100 feet, and that only at that depth solid rock is encountered. From a thorough personal examination made of all the borings and shafts established all along the line, I can indorse the statements made as to the surprising formation of this hill, and consequently in digging this great trench, as well as other portions of the line, a great saving will be effected, *which will materially reduce the original estimates as to hard rock extraction, this bearing directly on the cost of the canal.*

It may be said here that the rocks from this great cut will be utilized in the construction of the large dam near Gamboa.

We now enter upon the last section of the canal, which takes for its course the valley of the Rio Grande.

The greatest part of the canal will be dug in alluvious soil, and in the great marshes of its borders and the upper portions of the river there will be but little difficulty in the execution of the work by following the valley of the river. At the mouth of the Rio Grande, on the contrary, it will be necessary to turn to the right to avoid the doleritic rocks of Gavilancito, which we find near the village of Pueblo, and the surveys near the mouth of the Rio Grande have discovered the fact that considerable rock work will have to be executed there. After passing the narrows at the mouth of the Rio Grande the canal enters the Bay of Panama, as already explained.

As the Chagres has several affluents, such as the Rio Trinidad and others on its left bank, draining the western portion of the isthmus, it will be necessary to construct a lateral channel on the left bank of the canal for quite a distance, until the waters will be able to join the main Chagres again above Palo Harqueta. The cost for regulating the course of the Chagres and its affluents has been estimated at 75,000,000 francs.

The lateral channel on the right bank will be fed by an outlet from the dam at Gamboa, and will have a capacity of 200 cubic meters per second. It is the intention to supply Panama and Aspinwall with fresh water through this lateral channel.

The locality where the canal will take to the bed of the Chagres River above Matachin is 14 meters above sea level, or 22½ meters above the canal bottom.

The dam to be constructed is 40 meters high, and located about two miles from the railroad. The dam will have a length of 1,500 to 1,600 meters, will be 960 meters wide at its base, and 240 meters at the top. It will be a true artificial mountain, and the reservoir or basin so formed will contain 100,000,000 cubic meters of water. There are eight lines of railways in course of construction from the great cut at Culebra to transport the material to the dam. Four of these lines will be used for the rock trains for going, and four for returning. (The ties for these lines are being sent from San Francisco.)

The surface of the inundated basin will be 180,000 hectares.

The abutments of this great dam will lean against two hills, the Cerro Gamboa and the Cerro Barucco, where they will meet good rock foundations to rest upon. Soundings of the river have been made to get the exact depth to the rocky bottom, so as to build up from a solid base, but the exact depth cannot yet be stated, and opinions can only be formed from the inclination and the formation of the two cerros. The outlay for this dam has been estimated at 100,000,000 francs. This state of dam is not new; they exist in France, Spain, and Belgium. The one at Alicante, Spain, is 50 meters high, and has been built for 300 years.

The reservoir or basin thus created by this dam will be 17 miles long, 8 miles wide, and 120 feet deep, and will drain the whole of the upper Chagres country.

Owing to the difference in tides, a current will be created, alternately going from the Pacific to the Atlantic in a portion of the canal the direction of the flow changing according to the state of the tides.

These currents will aid ships to enter the canal on both sides. The same effect takes place at the Suez Canal. There also on account of the tides some engineers thought it would be necessary to establish tide locks. As it may become necessary to build one at the Panama entrance, 12,000,000 francs have been appropriated for that purpose. The influence of the high tides in Panama Bay will not be seriously felt in the canal, as the tide rises slowly and gradually. It is argued, and it may be possible, that when the canal and the port at Panama are built, the tide may not rise so high as now, or at least the effect will not be very sensibly felt, since the rising tide will have a chance to enter the canal, spread out into deep waters, and not be obliged to climb up the shores. This looks reasonable, and it is probable that when the two oceans are united, the tide on the Pacific will not be so high.

As the high tides in Panama and Colon happen at the same time, the average or mean tide at Panama and Colon will also happen at this time. As soon as the water rises above the middle tide at Panama, a slow current will take place in the canal, and will grow swifter as the tide rises. Since the tide rises at Panama on an average 20 feet, or 10 feet mean tide, and is counterbalanced in a small proportion by the mean tide of 9 inches coming in at Aspinwall, it is estimated that the current thus created will be about 4 knots per hour. The tide lasting about 6 hours, it will travel at about 24 knots, or reach about midway in the canal.

It is interesting to know what creates so high a tide at Panama, and such a low tide at Aspinwall. According to arguments brought forward on this subject it is claimed that the configuration of the Bay of Panama is such as to accumulate a large volume of water at its head, and thereby causing a very high rise; this rise, however, being slow and gradual, the current created thereby in the canal will be slightly felt.

The commission of the International Congress estimates that the direct commerce between the Atlantic and Pacific is ten million tons, but it adopted a basis of six million tons to pass yearly through the canal.

The question of navigation will greatly bear on the question of tonnage, as some vessels may find it convenient to pass one way through the canal, but may not return by the same route.

Some vessels starting from points on the Atlantic will, for instance, go to Australia or Japan by the Panama Canal, but since the winds carry them in that direction they cannot return the same way; they will, therefore, take the back route *via* Suez, thus making the tour around the world.

PREPARATORY WORK.

In a work of such gigantic proportion as the digging of a canal, it is not only the execution of the work which has to be considered, but also the solid foundation upon which it has to be established, so that the work may be perfect.

It is almost impossible for a stranger who has never seen the isthmus to imagine what an undertaking it was for the young men who came on the ground to make the first surveys. The greatest consideration is due to these gentlemen, who in spite of immense obstacles have done so much in such a short time.

At first sight it seemed impossible, or at least very difficult, to establish the configuration of the land on account of the impenetrable forests which cover the whole territory, even on the highest summits. It was therefore necessary to abandon the ordinary ways of proceeding, and to seek other methods than the ordinary triangulations to establish an exact map. The following is the method the engineers have chosen: As the tracé proposed by Messrs. Wyse and Reclus keeps near the railroad, the engineers took this road as the basis of their operations.

Hardly had the first expedition landed on the isthmus, on the 20th January, 1881, when two brigades of operators were put in the field to get an exact base line of the railroad.

This being done, several brigades were distributed between Colon and Panama with the mission to start from different points on the railroad and to cut transversal pathways (trochas) through the dense forests, by means of the natives who use their long knives (machetas), with astonishing rapidity hewing down enormous trees; thus a whole series of trochas were opened up the hills or down the valleys, according to the configuration of the country.

Later on another brigade was set to work to make the great longitudinal trocha representing approximately the true tracé or axis of the canal, according to the surveys of Messrs. Wyse and Reclus. Thus was it made possible to have a very exact map and determine a definite line of the axis of the canal, taking in consideration its geological features gathered by a special brigade under the direction of Mr. J. Roux.

In this manner transversely to the axis of the canal, over 200 kilometers of the trochas have been made, besides the great longitudinal trocha, 20 to 30 meters wide, following the whole line of the canal from one end of the isthmus to the other. In the hilly sections of the isthmus, as between Paraiso and Matachin, the trochas are 122 meters apart from each other; between Emperador and Obispo, their distance is 50 meters from each other; and at Gatun 30 meters.

Besides this the engineers have made the triangulation of the principal cerros. Among the series of leveling and surveys may be mentioned the plan of Panama; the plan of the coast between Panama and the mouth of the Rio Grande; the course of the upper Chagres for more than 45 kilometers; and of the lower Chagres for 70 kilometers; the hydrographic plan of the Bay of Colon, with all the soundings in the two bays.

This important and exceedingly hard piece of work being finished, the engineers were directed to survey the ground from a geological standpoint. Soundings were established along the line of the tracé; four sounding machines are driven by steam, and numerous others by hand.

To study the slopes and curves, large shafts are being sunk 8x12 feet, and a geological map has been made showing the formations.

Naturally the most important points are on the Pacific side, and some important results have been obtained, especially in the Culebra section.

Nothing is more astonishing than the geological formation of Culebra Hill, and before the soundings were established the supposition was that an immense rocky section would have to be cut through. Estimates were made accordingly; but on attaining certain depths, the proofs were brought to light that the basin of the canal would lie in a volcanic rock below an immense mass of decomposed matter.

The soundings and shafts show immense beds of clay, caused by the gradual decomposition and degradation of a greenish pyroxinic rock underlying this decomposed mass. For instance, the De Lesseps shaft recently was down 34 meters, and the hard formation had not been met with as yet. Embedded in the decomposed matter are found rounded nodules of the original mass, sometimes of a very large size. The De la Cote shaft, also at Culebra, shows at a depth of 20 meters decomposed matter, consequently the original opinion and estimate that the hard rocks would be met with at an average depth of 12 to 14 meters is fortunately all upset, and an average depth of 40 meters may be estimated for this decomposed matter in the Culebra section, and may be increased in other sections. A saving of perhaps fifty million of francs may be effected in the excavation work in consequence of these discoveries. At other points the ground has also been bored, sometimes to the depth of 20 meters, the result showing that the generating hard rocks are deeper than at first supposed.

These are the geological facts which the surveys and explorations have proved.

It affords pleasure to be able to state here that, in a discussion which took place on the isthmus during M. De Lesseps's visit there last year, an eminent geologist who accompanied the expedition held strongly to the opinion that only a slight layer of friable and movable ground could be relied upon, and that hard rocks would be encountered at a small depth. By one of those deductions so frequent with men of genius, M. De Lesseps thought "that he could assert that such gigantic trees ought to have roots plunging deeply into the earth!"

(M. De Lesseps crût pouvoir dire que des arbres aussi gigantesque devaient avoir des racines plongeant profondement.)

As the soundings are of such importance to the projected execution of the work, it is perhaps well to enumerate them.

There are some 30 soundings and shafts along the line.

Four great shafts worked by steam power, which have reached the depth of over 35 meters, are:

The F. de Lesseps shaft at an altitude of 72 meters above sea level; the Couvreux and Hersent, on Culebra Hill; the Thompson, on the right bank of the Chagres, near the great dam at Gamboa, on the hill side; the Isthmenia, near the Barbacoas station.

Shafts and soundings worked by hand, having less than 35 meters depth:

Blanchet shaft, situated in the great trocha, 100 meters to the right of the road leading to the Sardanella gold mines; Reclus shaft, half way between Emperador and Culebra; shaft of the fiftieth kilometer; Sossa shaft, on the southern slope of Culebra; two shafts located at the falls of the Obispo River; fourteen shafts are located between Lion Hill and Colon; five shafts near Panama and along the coast; one shaft at San Miguel.

At the station of Emperador all is life and activity. This will be one of the important points on the line, and good quarters and offices have been provided for the officers and men of the company there. A large machine shop with foundry, forges, etc., is being built for the repairs of machinery. Messrs. Huerne, Slavin & Co., of San Francisco, are building there a large village under contract with the Canal Co., and all their material, such as lumber, tools, etc., is being sent there from the United States, as well as their skilled carpenters. The geological and mining department of the Canal Co. was under the direction of José Roux, a graduate of the School of Mines in Paris, an exceedingly competent man.

Mr. Pedro Sossa, a native of Colombia, who has received a thorough American education at the University of Troy, New York State, is also employed by the company, and is considered one of the ablest engineers of the Canal Co.

Another large and important station is established at Gamboa, under the direction of Mr. Carey. This is one of the points where the ingenuity of the engineers will be taxed to the highest degree, as it is thought to be the critical point of the canal, the work embracing the construction of the dam and the regulation of the flow of the Chagres.

At the Gatun station great activity is displayed. Large storehouses and buildings are being constructed by New Orleans builders, and here also Messrs. Huerne, Slavin & Co. are erecting a village for workmen.

One of Hersent's monster excavators, all mounted, is ready for work. These excavators have a capacity of digging up 1,200 cubic meters of earth per day, and quite a number of these will be set to work.

Small steamboats belonging to the Canal Co. are discharging machinery and tools, and a small flotilla of iron barges brought from France is ready for service. Here digging had been inaugurated.

On the Island of Flamenco four self-registering tide-gauges (mareographes enregistrateurs) are established to study the tides of the Bay of Panama.

Two aerometers, with electric indicators, are erected for the study of all variations in intensity and direction of the winds.

Several fluvigraphs (current gauges) set up along the Chagres give by the aid of their registering apparatus an exact indication of the rise and fall of the river and its flow. This combination apparatus is of recent invention and offers a very convenient mode of study.

And last, in all the camps along the line, 25 of them may be counted, are to be found maximum and minimum thermometers, psychometers, evaporators, rain gauges, and other instruments for regular observations of climatic conditions of the atmosphere at the different points of the isthmus.

At Colon there is a special service with a central office, a maritime agency with a full complement of officers, artisans, and workmen for discharging machinery, utensils, and other material for the erection and repairs of machines, apparatus, etc.

There is a large quantity of material and machinery on hand: 200 cars for gravel trains; 12 locomotives; 2 pontoons; 2 steam cranes; 18 scows; 2 dredges; sawmills, railroad iron, dump cars, etc.

At Colon the storehouses cover a space of 14,000 square meters, and are filled with material, machinery, etc.

Five chalands (barges), 2 steamboats navigate the Chagres, and at Panama another steamboat is in use for the hydrographic studies of the bay.

One excavator at Gatun, one at Colon.

The sawmill at Colon is in operation.

Between Matachin and Paraiso bridges have been built across all the rivers and creeks, and Gatun will be made the great inland port.

The company has good quarters at Gatun, Colon, San Pablo, Mamei, Obispo, Matachin, and Paraiso.

As to workmen, the negroes from the West India islands are found to be quite up not alone in ordinary work, but also as artisans, carpenters, blacksmiths, and masons. A bridge has been built by them at Emperador, which would have been creditable to white labor. They take readily to mining work, and swing a pick to perfection after a short practice. They support this hard climate well, and my opinion is that the canal will have to be built by the negroes of the Antilles. They are furnished with the best of provisions. Ordinary laborers earn about $1.00 per day. They are generally paid by the hour, as some of them do not like to do a full day's work.

All this immense work will be done by the house of Couvreux & Hersent, in Paris, who have taken the contract. This is a well-known firm in Europe, where they have successfully carried through some of the greatest engineering works in our modern times, like the regulation of the flow of the Danube, at Vienna, and at its mouth at the Black Sea; the building of the large dry docks in Toulon. The work of regulation of the Escaut was carried out by them, as also the Canal of Gand, at Terneuzen, and many other enterprises. There is no doubt that they will succeed in uniting the waters of the Atlantic and Pacific, and overcome all the difficulties which, of course, are to be found in the isthmus; but with capital, the skill, enterprise, and the resources of these men, they will conquer them.

QUANTITY OF MATERIAL TO EXTRACT.

The following are the quantities of material, rock, and earth to be extracted in the digging of the canal, as estimated by the commission who had charge of that work.

Although the numbers in an aggregate are correct, the proportional numbers as to hard rock and soft material will have to be changed, as subsequent explorations (herein before explained) have demonstrated that at Culebra and other points the decomposed layers are of great depth.

CUBIC METERS TO EXTRACT.

Below Water Level.

Sections.	Mud and Earth.	Decomposed matter to be worked by Excavators.	Hard Rock.
	Cubic Meters.	Cubic. Meters.	Cubic Meters.
On the Atlantic side......	9,330,000	300,000	3,775,000
" Culebra division..	....	..	2,634,000
" Pacific side.......	2,675,000	....	377,000
Totals.........	12,005,000	300,000	6,786,000

Above Water Level.

Sections.	Mud and Earth.	Decomposed matter to be worked by Excavators.	Hard Rock.
On the Atlantic side.....	23,710,000	825,000	3,060,000
" Culebra section....	2,167,000	...	23,199,000
" Pacific side.....	1,473,000	....	1,475,000
Totals..............	27,350,000	825,000	27,734,000

Giving a grand total of 75,000,000 cubic meters.

These figures have to be modified in consequence of facts discovered by recent soundings, and about 30 per cent. should be taken off the amount of hard rock to be excavated above water level, and added to the middle column as "middling hard decomposed matter worked by excavators," making quite a difference in the cost of extraction.

SANITARY CONDITION.

In regard to the sanitary condition, of which so much has been said, as in many tropical countries, malarial fevers are indigenous there, and affect those not accustomed to the climate. When the work was first inaugurated the engineers exposed to a burning sun suffered much. The statistics of the company show the following figures:

Number of Employes.			Death rate.
In February, 1881.	350	men.	0
" March,	425	"	1
" April,	485	"	2
" May,	544	"	1
" June,	588	"	9
" July,	1,108	"	10
" August,	1,150	"	4
			27

During June and July the mortality was greater on account of the yellow fever brought from outside. Panama being a free port, vessels enter there without being quarantined.

The sanitary service is well regulated; a hospital is being built at Panama for 300 beds; one at Colon for 100 beds; besides five ambulances are being established, one at Gatun, Emperador, Culebra, Gamboa, and Mamei.

The work is divided in several departments.

1. *The Administrative*, having under its charge secretaries, bookkeepers, stores, provision warehouses, and transportation.

2. *The Department of Studies*, having in charge the bureau of studies, the steamboat Lottie, the brigade of Ancon, the marigraph of La Boca.

Brigades of Paraiso.
" " Culebra.
" " Emperador.
" " San Pablo.
" " Obispo.
" " Gamboa.
" " Upper Chagres.
" " Matachin.
" " Buena Vista.
" " Colon.

3. *Preparatory Work.*—Central office with bookkeepers. A separate transportation department, store houses, maritime agencies; Gatun section; and 723 native laborers were at the time of my visit under the charge of this third department.

The Company "du Canal Interoceanique des deux mondes" was legally organized on the 4th March, 1881. Before this date they had no right to make any outlays or enter into legal contracts, or employ people. But through the private energy and enterprise of M. De Lesseps, the first brigade of engineers was sent out from Paris on the 6th January, 1881. Without an agreement with the railroad company it was impossible for the canal folks to do any serious work, except such studies as were necessary for preliminary arrangements, since the railroad company had the right of way on the isthmus for any kind of route. The canal company had therefore to buy this road. Its purchase was consummated for the sum of $21,000,000. Official notice of it was only received in Panama on the 24th of July, 1881; therefore from this date only they were able to commence serious work. It will be seen, therefore, that the time has been quite short for the immense amount of preparatory work required to set an army of men into the field.

The actual digging at Culebra was to be started in December, as this point will be attacked first, the regulating of the flow of the Chagres through the big dam at Gamboa having to be carried out first before the shore ends can be attacked. The rocks of Culebra Hill will be required to commence the work.

GENERAL ESTIMATE OF COST.

1. *Excavations (siding included).*

a. Excavations above water:

	Cubic Meters.	@Francs.	Francs.
Earth............27,350,000	27,350,000	2.50	68,760,000
Rocks of mean hardness	825,000	7.00	5,775,000
Hard rocks..........	27,734,000	12.00	332,808,000
Excavations of rocks where pumping is necessary.........	6,409,000	18.00	115,362,000
b. Dredging and excavations under water:			
Mud and alluvial soil.............	12,005,000	2.50	30,500,000
Hard soil capable of being dredged,	300,000	12.00	3,600,000
Excavation of rock under water,	377,000	35.00	13,195,000
Total...			570,000,000
2. Dam at Gamboa; length 1,600 m. to maximum height...			100,000,000
3. Channels for regulating the flow of the Chagres, and for the Obispo, Trinidad, and other affluents........			75,000,000
4. Tide-lock on the Pacific side........			12,000,000
5. Breakwater in the Bay of Limon....			10,000,000
			767,000,000
6. Add for contingencies..............			76,000,000
Grand total......			843,000,000

DEFINITE LOCATION OF THE LINE, WITH SOME IMPORTANT ALTERATIONS.

In consequence of recent fuller surveys made by the engineers of the company, the tracé of Messrs. Wyse and Reclus has undergone some important changes, and as the line has been definitely located and the execution of the work commenced, let us enumerate these modifications, which will reduce the cost and facilitate the work.

In some places, where the nature of the ground admits of it, the radius of the curves has been diminished.

On the Atlantic side the direction of the line has been so modified as to start from the point where Folks River enters the Bay of Aspinwall. This is a saving of some 300 yards in the length of the line.

From the Folks River the new line continues for about three and a half kilometers, and avoids a curve to the north, which had formerly been accepted. The lines again meet at one kilometer before reaching Gatun. At this place no change has been effected in the direction of the channel, which, however, is to be protected by formidable embankments. The neighboring promontories will, if necessary, furnish materials for these works. At Gatun the curve in the canal is to be strengthened by cutting the great bend of the Chagres River, so that this stream may flow from there uninterruptedly to the sea. The cutting will be some distance west from Gatun.

The curve formerly laid down between Gorgona and Matachin, or Gamboa, has been but little changed in the contour. The changes at the Matachin dam are radically important.

It is intended to rest the foundation on solid rock in masonry below the river bed. The borings sent down established the fact (as before mentioned) that bed-rock was only to be found at considerable depth at the first proposed site; the same has been moved up the river a distance of 450 meters to the base of the Cerro Santa Cruz on the west, and Cerro Obispo on the east. The distance separating these two great abutments is not more than 800 meters. At the new site for the dam firm rock has been touched at seven meters from the surface.

This change in the depth of the rocky formation occurs in consequence of the more obtuse flanking angles of the hills having formed there pockets of indurated clay and rock at a shorter distance underground than is to be found near the site first selected. This new dam will be 510 meters wide at the base, and sloping up to 100 meters to the top, and will be 40 meters high.

The new plan contemplates a tunnel for the escape of the surplus waters of the Chagres not retained by the dam, instead of an open cut, as was at first devised. The tunnel will extend down the river bank for a distance of 500 meters from the crest of the dam, running along to the Quebrada de Cuatro Calles.

This aqueduct will have a discharging capacity equal to 200 cubic meters of water per second.

On the west side of the Chagres the auxiliary canal will begin at Rio Caño Quebrado, near San Pablo.

From the Culebra to the Pacific very little alteration, if any, has been made in the course of the line.

Generally speaking, the old line will be preserved as nearly as possible.

No tide-lock will be needed at Aspinwall, but one cannot probably be dispensed with at Panama, where the twenty and odd feet of rise and fall in the tide seem to require it in order to preserve something like a level and prevent too much of a current in the canal.

In following now the definite line of the canal from Aspinwall to Panama, we start from the point on the north of Manzanilla Island (Aspinwall), which is known as Folks River; the canal runs along to the bridge in the Mindi River, to the seventh kilometer, and so on up the little valley, half

a kilometer, to the Mindi Hills. Here the new and the old lines are joined again, and the common axis of the canal continues uninterruptedly to Gatun. At Gatun the canal cuts off the curve in the Chagres River, and passes the little stream called Gatuncillo at twelve and a half kilometers from Aspinwall.

The line then continues up through to the adjacent marshes to the fourteenth kilometer, where it enters upon firm ground a little south of Tiger Hill. The tracing now makes a curve toward the southeast with a radius of 3,000 meters. Thence it goes over the marshes of Lion Hill to the eighteenth kilometer. Passing this and going on to the twenty-fifth kilometer the great waterway crosses the Chagres River, cutting off a somewhat sharp bend toward the northeast. The surface elevation near this crossing is 35 meters above the sea. The line now runs in a southwesterly direction, making a curve with a radius of 2½ kilometers. Between Buena Vista and San Pablo (25th and 35th kilometers) the old line has undergone very little change. At Tavernilla the canal cuts off a very sharp elbow in the river and continues on its way to the great railroad bridge at Barbacoas. From there to Matachin some alterations have also been made.

According to these changes there will be three crossings of the canal under the railway, namely at the 25th kilometer, near Buena Vista; the 36th kilometer, at San Pablo; and the 55th kilometer, at the foot of the Culebra.

The deepest shafts at present are the Blanchet, 65 meters; the Reclus shaft is 50 meters; Pedro Sosa shaft is 50 meters deep, and the material at that depth is indurated earth.

At the 58th kilometer the line strikes the Rio Grande valley. The Rio Grande offers few obstacles to the canal, which crosses it five or six times before nearing the small river Pedro Miguel, where the marshes begin at the 62d kilometer, and continue down to the mouth of the Rio Grande. Beginning at the Rio Grande Railroad station the line makes a long curve toward the southeast. This is soon followed by another bend in the contrary direction in the old plan, but the new line will continue straight after emerging from the curve at Rio Grande station, and so continue to the Pacific, passing between the Cerro Ancon and a little hill one kilometer southwest of it into the bay at the 71st kilometer. From its point of exit the waterway will be carried out into the bay for a distance of 3 kilometers to near the little island Naos.

The project of emptying some of the waters of the upper Chagres through artificial channels into the Pacific is receiving the attention of the canal engineers. A large portion of the water-shed in the upper valley would be drained if a low pass could be found, or a short tunnel could deviate its course by means of an upper dam, thereby relieving the pressure which the Gamboa dam will have to withstand during high water. This change would make a smaller structure than the one proposed sufficient.

Continued from SUPPLEMENT No. 344, page 5492.

THE MINERALOGICAL LOCALITIES IN AND AROUND NEW YORK CITY, AND THE MINERALS OCCURRING THEREIN.

PART II.

By NELSON H. DARTON.

Pennsylvania Railroad Cut.—This is the passage-way cut through the Bergen Hill, further to the south than the tunnels, where the hill is not of any considerable height. This cut is about a mile long, and joined by the cut for the New York, Susquehanna, and Western road, which branches off from the new Pennsylvania cut, and again joins it about a quarter of a mile beyond. There is also a short cut running in at this junction, which is occupied by the freight track of the Pennsylvania Railroad, and commencing at the end of the trestlework built over Jersey City. All the cuts have veins of various minerals in them, and these are so thickly scattered through the walls that it is impossible to detail them individually.

The greatest number of minerals occur near the Newark avenue bridge, and just south of it. Some are in a vein of chlorite, and others in veins by themselves. In going through the Pennsylvania Railroad cut, however, the veins may all be examined, and one will be well paid in so doing, if not by the beauty, by the abundance of the minerals found, but none has been found here that could compare in uniqueness with those found in the tunnels; but, as they are plentifully scattered around in the walls and débris near them, it may be well to secure them. The mode of access to the cuts is either by the Newark avenue car, from the Pennsylvania Railroad ferry, or by walking up the track to them, a distance of about a mile and a half, or by the trestlework between the Erie and Pennsylvania ferries, where the distance is much shorter. The minerals to be found in sufficiently fine specimens for the cabinet, and in fair abundance, are as follows:

Calcite.—This mineral is, of course, very abundant, as many veins are to be seen in all the walls of the cuts. There are few very unique specimens of the first form described in the first part of this paper, under "Weehawken Tunnel," except at the extreme western edge of Mount Pleasant, on the hill in the, at present, unworked cuttings, about two hundred feet from the signal-house on the Pennsylvania Railroad, just before arriving at Bergen Hill by way of the railroad track, and about a thousand feet from it. Here in the cavities of the amygdaloidal trap small but perfectly pure transparent crystals of calcite may be secured in limited abundance; they are frequently finely iridescent and very beautiful. The rock may be split where it is found full of these little cavities, a half-inch cube in capacity generally, and which on the surface, if it has been exposed to the atmosphere for any length of time, are empty.

Most of the rock in the above spot is full of cavities, and but little difficulty need be experienced in finding the part by this characteristic, which is confined to a space of a half acre. About a hundred feet from this, toward New York City, the side of the hill has been cut into for the rails of the road, and here a few crystals may often be found of even larger size, but consequently of less beauty, and less abundant. It is distinguished by being the only mineral just here, and the drop of acid, as I have explained before; sometimes excellent crystals, modifications of the regular form, may be found up in the cuts, and often of great beauty.

The other form of calcite, known as dogtooth spar, occurs, however, up in the Pennsylvania Railroad cut, in a vein of crumbly chlorite, near to the Newark avenue bridge, in the east wall. The vein, which is conspicuous, if one is seeking for it, is about a foot wide, and in it the geodes of this spar, of a pure wine-yellow color and beautifully grouped, may be found by digging; the vein is filled with them in abundance; the crystals are seldom over a half-inch in length, and generally less, but are remarkably unique, and, as this locality has only been known to me, have been but little molested. The characteristics, which I detailed under the first description of this mineral under "Weehawken Tunnel," distinguish it.

Datholite.—Besides dogtooth spar, in this vein of chlorite there occurs considerable datholite, also in geodes or crumbly masses of the peculiar-shaped crystals of this mineral, and frequently very beautiful. I have taken some quantity from this locality, but there is plenty of it left, and may be readily obtained by digging away the loose chlorite with the chisel. It also occurs in the loose rock from place to place in this cut, and often is excellent-sized specimens; it is not, however, over-abundant. Care should be taken not to confound it with the calcite which frequently occurs in forms closely resembling it, but the drop of acid, which should be frequently used in examining the minerals from Bergen Hill, will quickly show the difference.

Pectolite is very abundant in the Pennsylvania Railroad part of the cuts, and although the veins are seldom over three-quarters of an inch thick, being so near the surface of the rock, it may be found in excellent specimens. There is only one vein of any prominence, and that is in the west wall, a few feet north of the Newark avenue bridge. It is quite prominent, as is also a vein of calcite very near it, and fair-sized masses may be cut out with very little difficulty. Some small pieces may be found in the loose earth and stones between the temporary rails on the opposite side, under and in the cars. For a description of the mineral I refer to Part I. of this paper.

Phrenite.—But little of this mineral is to be found, except a few small plates of it in the loose rock and dirt under the before-mentioned bridge, and as it is very inconspicuous it would be hard to find and distinguish it from the calcite with which it is associated.

Stilbite.—This mineral is quite abundant, but in poor specimens. It occurs in a great number of places in the cuts, but would be passed unnoticed, as when it is drused upon the rock holding it, it resembles ordinary soil or dirt, and possesses no beauty in that form. Sometimes a piece of pure white may be obtained with the crystals over a half-inch long, but it is rare, and only found in the loose rock, which is fast being carted away. Staten Island is the locality in which to find this mineral in any abundance and with surety.

Feldspar.—This mineral occurs very plentifully at either end of the cut; at the west, with rough crystals of hornblende and the feldspar, massive, and at the south end, or beginning of the cut, just beyond the signal-house before-mentioned, and opposite where the tracks have completed about half of the curve, where the feldspar may be obtained in excellent crystals. It occurs here in two or three veins, on the side of the track (as the rock is only cut out on one side), about three or four inches thick, and the crystals piled upon each other in the vein in apparent disorder. They are about three-quarters of an inch long and one-quarter wide, by the same thick, with modified terminations; often in flat tables with beveled edges. The color is a yellowish gray; the specific gravity is about 2·5; the hardness, 6. It is almost entirely infusible before the blowpipe, and is not acted upon by acids. The general characterictics of this mineral distinguish it from any others in this vicinity; the form of oblique rhombic prisms is peculiar, and from being the only mineral in the immediate locality at once distinguishes it.

Pyroxene.—Masses of a form of pyroxene, of a greenish color on the weathered surface, occur in veins toward the western end of the cut, and has no value as a mineral, as it only occurs in confused masses, without beauty or rarity, and is not worth carrying away, unless it should suit the fancy to do so.

LOCALITIES IN THE OUTCROP OF BERGEN HILL.

There are many of these, and at present I will only detail two, as in them occur two minerals which will not probably be found elsewhere, and are excellent additions to the collection. The other localities are for the before-mentioned species, and are, as a rule, sadly emptied by this time, so that but little satisfaction would be gained by going to them.

Analcime.—The first of the two localities is that for analcime. It will be rather difficult to find, but I will give as minute a description of it as possible. Between the two tunnels, the Erie, and Morris and Essex, is a chemical factory right on the edge of the hill, and nearer to the Morris and Essex, and directly behind it Hoboken avenue commences to climb the hill, as does also the water-pipe crossing the meadows in front. It has a tall chimney, and a large, square white house, with most of the windows boarded up, very near it; these are conspicuous and readily accessible from the Hoboken ferry. About a hundred feet north of this factory an indent about twenty feet deep is cut into the bluff and partially filled with loose stone blasted out. Near the extreme southwest wall of this cut, and two thirds way up the hill, is the vein in question. It is of soft, earthy matter, and filled with the analcime, most of which resembles flat pieces of old bone more or less corroded, but by digging into it, or searching in the small pile of earth immediately in front, masses holding the crystals may be obtained. They are, together with the matrix holding them, about a half-inch thick, and a dirty hue, from which they may afterwards be cleaned by washing in diluted muriatic acid. They are highly altered cubes or trapezohedrons, having a specific gravity of about 2·2, and hardness fully 6. It fuses before the blowpipe, without intumescing, to a clear, glassy globule, and may be gelatinized by long boiling in the acid, or at least in part. As there is plenty of this mineral here, it extending away into the hill, fine specimens may be obtained by patient digging and assorting.

Spathic Iron.—The other variety is of spathic iron, and is the cutting into the face of the bluff about a thousand feet north of the intended entrance of the Ontario tunnel, up near the surface, and scattered in greater or less abundance in all the top cuttings. It is of a rusty brown color, and occurs in globular concretions in the rock, or in bunches of clay in its clefts, sometimes an inch in diameter, often less. It is readily recognized by its form and color. It has a specific gravity of about 3·8, and hardness of fully 5. It may be dissolved in the acids, and before the blowpipe it blackens and becomes magnetic. It is a carbonate of iron, and by careful trimming may make a fair cabinet specimen. It is hardly worth making a special trip for it, but when at the Ontario tunnel this may be included in the trip.

We will leave Bergen Hill here, or rather this end of it, as we will meet the same formation again down on the western portion of Staten Island, where it is all below the surface proper of the land; but some passing remarks may be of value. It is hardly to be expected that in these localities every mineral mentioned will be secured, but it will well repay one to repeatedly visit the different cuttings and quarries over the surface, and a fine assortment will be readily obtained, and, perhaps, other localities discovered. It also affords an interesting study to one who would be careful to consider the localities and their peculiar surroundings, as the aspect of the trap, etc. This knowledge will be a key that may be of use in unlocking the localities of similar minerals in other parts of the country. It is always well to be observing in these studies, and it is often the road to a successful mineralogical career, as the minerals are not always the only desideratum in these trips.

STATEN ISLAND.

Quite a variety of minerals occur on Staten Island. On the eastern part, in the serpentine, are to be found the steatitic minerals of great beauty, and here the finest representations of them occurring in the United States. On the western part, in the trap, or, as it is there called, granite quarries, is a quantity of the zeolites mentioned under "Bergen Hill," and often of great beauty. In the center, and to the south of the island, occur the many and varied forms of iron minerals and ores, besides beautiful quartz crystals, in groups, upon the serpentine. Thus, Staten Island may be said to be very rich in mineralogical forms.

The stations as I divide them here are: 1, Pavilion Hill; 2, Graniteville; 3, The Iron Mines.

1. *Pavilion Hill.*—This is that prominent hill in Tompkinsville, about a half-mile from the first landing on the south shore ferry, and straight up the Richmond turnpike, commencing at the ferry house. It has a half-dozen prominent trees on top, and embellished with the sign of a story-paper, of large dimensions, facing the bay; its sides are of the outcropping rock, serpentine, which is exposed at nearly every point.

Some years ago the shafts, now partially filled, on top of the hill, were used, and the valuable veins of soapstone and asbestos worked. Most of the minerals on exhibition from this part of Staten Island were obtained from these shafts, which, as they are not open now, are unavailable. But the sides of the hill, especially the south and west, are strewn with the minerals of greater or less beauty and abundance.

The northwest end may first be examined, and then the hill examined to the west and south, finally climbing it on the southeast side, and coming down on the eastern side. In this way all the veins of asbestos, soapstone, etc., as described below, may be examined as they crop out on the sides, or, if covered, their débris selected from.

Then at the southeast end of the hill the Richmond road, which forms the eastern border of the hill, may be struck, and by walking south on it for about a half-mile Eakens and Grimes hills may be respectively climbed and examined, they both facing this road and near the breweries of Bischoff and Becktel. They are very marked characters, and cannot fail to be observed by the outcropping serpentine. In these outcrops are the veins of the various minerals scattered in confusion.

After these outcrops are examined, one, if disposed, can then go up to the Serpentine road, examine the iron mine there, and procure the forms of iron ore, etc., and then set out, as I will detail below, for the iron mines proper.

The minerals occurring in the serpentine of Staten Island are as follows, and for these before-mentioned outcrops:

Steatite, or Talc.—Three varieties of this mineral occur here. The first is the foliated talc. This occurs in masses from the size of walnuts to three or four feet in diameter, generally in veins with poorer varieties, the finest foliated talc occurring in the United States being found here in Pavilion Hill. It is of a light green or silvery color, and made up of easily separable folia or layers; it occurs all over the sides of the hill in various conditions and tints of color, and sometimes prisms of it may be found. It runs into the other varieties, and especially the indurated form, which is very much harder and thicker folia, the colors not being so delicate. Then there are the impure forms of both, known as potstone, which is coarse and more or less granular.

These talcs have a specific gravity of from 2·4 to 2·8, and are all so soft as to be readily cut with the finger nail. Before the blowpipe it may be fused by long-continued blowing. It is almost entirely insoluble in acid. Its chief distinguishment is its softness.

Asbestos.—This mineral, which here occurs in the finest specimens to be obtained in the United States, is very abundant in many forms and gradations. Properly it is in fibrous masses, from which the fibers may be readily picked. They are generally fine and silky, and are thus characterized: It is generally of a green color in mass, and the fibers of a nearly pure white; it, however, also occurs here red and yellow, and frequently hard and fibrous, like a piece of bamboo. The specific gravity is very variable, but generally about 3, and hardness 5. It is insoluble in acids, but it readily fuses before the blowpipe if a single fiber is presented, and more or less difficult to fuse if in mass.

It is distinguished generally by the fibrous masses in which it is found. It occurs on and around Pavilion and Grimes hills, and at the first iron mine mentioned under that head, in great abundance. Frequently the fibers are a foot long and of great beauty; when thus, and of a pure white or pearly color, it is termed amianthus. Sometimes crystals may be found about an inch in diameter, which might not be recognized until scratched with the point of a knife-blade, when the fiber would show. If not found in the veins that hold it, which are from one to four inches thick, and covering Pavilion Hill, it may be found plentifully in the loose rock and the many varieties secured.

Gurhofite.—This peculiar mineral is very abundant in Pavilion Hill, especially the northeast end; resembles a piece of porcelain, it generally being of a pure white color and homogeneous in appearance, while very hard, compared with similar colored minerals, 4 being its hardness. It occurs in beds from one-eighth of an inch to an inch thick, and having the darker-colored serpentine on either side, or the indurated talc. Its specific gravity is 2·9; it dissolves slowly in acids, with effervescence like calcspar, but is distinguished from that species by the two not occurring together and the greater hardness; from magnesite, as mentioned below under "Dolomite." It is infusible before the blowpipe, and glows like calcspar. It is a carbonate of lime and magnesia, containing silica, and a showy specimen when of good color and large size.

Brucite.—This rare and beautiful mineral occurs sparingly on the west side of the hill, in place in the outcrop, and among the loose rock all around the hill, and in Eakens Hill. It sometimes resembles talc, but has a purer white color; is translucent, and readily dissolves in acid, without leaving a residue or effervescing; its hardness is only 1·5 and specific gravity 2·3. It is infusible before the blowpipe, but becomes crumbly. It is made up of

thin, easily separated, transparent folia, and can be bent into shape—in other words, they are flexible.

It occurs in the seams of the rock, constituting beds or veins, about a half-inch thick generally, and when in place differing in appearance but little from the minerals adjacent to it, except by its whiter color, and is only distinguished from the talc, which it so closely resembles, by readily dissolving in the acids and by lighter color and greater transparency. It is a good plan to carry a test tube with one in this trip and some acid. As this mineral readily dissolves in the cold, heat is not necessary. It may be crushed under the hammer to facilitate its solution, and thus the bringing of talc home for brucite, as is generally done, will be avoided.

I have known mineralogists to go down to this hill, find a quantity of light-colored transparent talc, and take it all off for brucite, when on arriving home they find their mistake, and are highly disappointed in what they thought a very successful trip. The rarity of this mineral makes it much sought after, and if it were not for these mistakes the accessible localities would speedily be exhausted. It makes a very handsome cabinet specimen Care should be taken not to strike or indent it, as it is very soft, and its beauty easily marred.

Dolomite.—The finest specimens of this mineral in the vicinity of New York are to be obtained on Eakens and Pavilion hills. It occurs in the softer talcky serpentine, which is so abundant on both of these cuttings. There is seldom anything in its appearance that would lead one to secure it, but by trimming it down, as with calcspar, we may obtain sometimes very beautiful specimens. It resembles calcspar in form, but the crystals are less transparent, harder, and have a pearly luster. The colors are generally a dirty white, or tinged brown or yellow, and occurs in loose masses or pockets in the rock; sometimes it is handsomely crystallized in beds or imperfect geodes; but these are rare, and have to be blasted for, as they are out of sight at present, and to one not familiar with the position that they should occupy blasting would be ineffectual. A fair assortment of imperfect crystals may always be obtained, however, in the loose rock, especially on the southwest side of Pavilion Hill, and sometimes very fine specimens, as the rock is disintegrating rapidly and every day exposing more of the treasures in the form of fine specimens.

Dolomite is very difficult by extemporaneous testing to distinguish from calcspar, as it effervesces in acids, but more slower than it, and, besides being infusible, glows before the blowpipe. But as calcspar does not occur in this locality, these characteristics distinguish it from all the other minerals there which it may resemble, with the exception of magnesite, from which it is almost impossible to readily distinguish it, except by the magnesite not occurring in the large rhombohedrons, and by producing quicklime when ignited before the blowpipe, as calcspar also does. The quicklime manifests itself by heating and swelling up when a drop of water is allowed to remain in contact with it for a few minutes.

This is the same principle upon which the production of quicklime is based, the limestone consisting of calcspar or partly of this dolomite, which is a carbonate of lime and magnesia, as it generally does when this is heated, the carbonic acid is dispelled from it and the lime is left in a caustic state. This is difficult to apply on the small scale of a blowpipe ignition, but may be accomplished if care is taken. The powder produced by the ignition on the platinum loop may be carefully placed on a pile on the palm of the hand, a drop of water placed upon it; and if it is quicklime, the heat of the slaking will be very distinctly manifested. The specific gravity of dolomite is 2·8, and hardness nearly 4.

Magnesite.—This mineral is fairly plentiful, as veins and seams in the rock on all the hills. It is generally in the form of granular aggregations of imperfect and small crystals of a white or yellowish white color, and hardness of about 4, specific gravity about 3. It dissolves in the acids slowly and with but little effervescence, and is infusible before the blowpipe. It frequently occurs as tough masses, covered and made up of very small, glistening, sharp-pointed crystals, and beautiful specimens like these may generally be readily obtained. The only thing that it closely resembles is dolomite, from which it is distinguished, as mentioned under that species. As the forms of this mineral down in these localities are so varied, it is impossible to describe them. The veins are thickly interspersed through the rock where it is the hardest, and are about perpendicular, and form an indistinct line to an inch in thickness. No difficulty need be experienced in obtaining some satisfactory specimens of this mineral at any part of these localities.

Serpentine.—This is as a rock the entire northeastern formation of Staten Island, and constitutes the prominent and beautiful hills holding the iron ores which are soon to make Staten Island a great mining and industrial center, and also the soapstones and finest asbestos in this part of the country.

It is a part of the same stratum that outcrops at Castle Hill, Hoboken, and runs under the bay from that point to Staten Island, and out again under the ocean. But in all this mass of what we term common serpentine, there has not as yet been found a specimen of the precious, nor even the satisfactorily crystallized serpentine, which should have a dense oily body and be translucent at least, and of much darker and richer color than the rock.

However, the different variations of serpentine in itself are of some interest or beauty, and often considerable variety. Sometimes the serpentine is in a fibrous or semi-fibrous condition, of a lighter color, when it is termed picrolite, and only distinguished from asbestos proper by not fusing before the blowpipe; the fibers are generally stiffer and even brittle, and seldom as fine, and of a darker color than the asbestos proper. But as it runs into asbestos, and there are innumerable intermediate conditions as regards appearance and fusibility, it is almost impossible to draw a dividing line between them. The gravity is generally a little less, being for this and all serpentine 2·6, the hardness about 3·5. Most of it is to be found in the loose rock around the hill.

This is the only prominent varied form of serpentine occurring in the hills of this locality, the others belonging to the denser portion at Castle Hill, Hoboken. Specimens of the common serpentine are seldom to be obtained that have any beauty, it generally being quite soft, granular, and of a dirty green color, and much finer may be obtained at the last-mentioned locality, with a hardness as high as 3·5, while that in Pavilion Hill, etc., is not over 2·5 or 3. It is, however, merely a matter of taste as to whether one should secure specimens of the rock, as it possesses no mineralogical value, while the picrolite is much sought after and esteemed an excellent specimen.

Below is a table of the varieties occurring in this locality, and the distinguishing characteristics set prominently in view:

Name.	Spec. Grav.	Hardness.	Action of blowpipe heat.	Action of hot acid.	Color.	Form.
Steatite	2·4 to 2·8	1·5	Fuses on the edges with extreme difficulty.	Hardly any action.	Light to dark green.	Foliated masses.
Asbestos	3	5	Readily fused if a single fiber is taken.	Insoluble.	Dark green in mass, white in fibers.	Fine and silky, closely packed fibers.
Gurhofite	2·9	4	Reduced to quicklime, but infusible.	Soluble, with effervescence.	White or grayish.	Dense porcelainous-looking masses.
Brucite	2·3	1·5	Infusible, but becomes crumbly.	Readily soluble.	White or grayish.	Foliated translucent masses.
Dolomite	2·8	4	Reduced to quicklime—infusible.	Soluble, with effervescence.	Yellowish or brownish white.	Crystals or masses.
Magnesite	3	4	Infusible and *not* reduced to quicklime.	Soluble, with little effervescence.	Whitish.	Masses of very fine crystals
Picrolite	2·6	3·5	Infusible.	Insoluble.	Whitish.	Stiff brittle fibers.
Serpentine	2·6	2·5	Infusible.	Insoluble.	Dirty green.	Masses.

Steatite is distinguished from brucite by the solubility of the latter in acid, and by its darker color and less transparency. From serpentine by its softness, etc.

Asbestos is distinguished from picrolite by its fusibility and more flexible and finer fibers, higher specific gravity, and greater hardness.

Gurhofite.—The appearance of this mineral distinguishes it from dolomite proper, its burning to quicklime before the blowpipe from magnesite, its solubility with effervescence from some others it may resemble, and by having no cleavage into folia from steatite or brucite. As it does not resemble any others, it may be readily distinguished, except from dolomite proper, which often resembles it, but has not the porcelain appearance.

Brucite is distinguished from steatites, as stated under that species, and from what others it may resemble, by its structure and solubility in acid.

Dolomite is distinguished as stated under "Gurhofite."

Magnesite is characterized by not yielding quicklime before the blowpipe, from dolomite and gurhofite, and its solubility in acid with a little effervescence, from what others it may resemble.

Picrolite is distinguished from asbestos as stated under that species, and from others by its form and insolubility.

Serpentine is known by its general characteristics and ready obtainability.

There will be found great difficulty in separating these minerals as they run into each other in insensible stages, and often one will possess the characteristics of a number of the others; consequently specimens in this confusion had best be rejected unless of unique form, and another trip to the locality undertaken to obtain the pure minerals.

GRANITEVILLE.

We now come to our second station in the trap again, in and near Graniteville. The rock is cut into in two places here; first, the upper quarry, is a very extensive one, about a quarter mile south of Elm Park landing, on the north shore of Staten Island ferry. It is just to the west of the Morning Star road, which commences about a hundred feet east of the ferry dock and opposite to the brick factory, with its prominent chimney, on the other side of this road.

The second or lower quarry is not so extensive, but richer in certain minerals, is down below Graniteville, on the same road, about a mile below the upper one. It is a quarter of a mile west from the Morning Star road, in the lots, and they must be crossed from Washington avenue, which branches off west from the road, right in Graniteville; and but a short distance (one thousand feet) from the corner the fence may be climbed, and a few hundred south is the quarry. It may be readily found by these directions, or by questioning some person in the vicinity.

The minerals occur in both quarries in an area of very limited extent; in the lower quarry it is in the extreme eastern corner, on the higher ground, which is strewn with loose rock. In the upper quarry the localities are the extreme southern outcrop in the quarry, now partly covered with grass, except the spot which I will detail, and also in the exact center of the quarry, low down in the unblasted rock, but where operations are now in active progress. The minerals are as follows in the order of their abundance, with their descriptions, etc.:

Feldspars.—Very fine specimens of these are very abundant in the upper quarry, and the specimens obtained have been of extreme uniqueness. It is only lately that the attention of mineralogists has been called to this locality for this species, and consequently it is without difficulty that excellent specimens may be obtained. The vein wherein the finest occurs is in the extreme south end of the upper quarry, below and near the boundary fence.

The locality will be recognized by the débris recently cut away by myself and others, and the peculiar appearance of the vein which runs the same direction as the fence, and has an area of, say, twenty square feet, exposed and covered with white crystals of calcite. Here one may procure an excellent assortment of fair-sized crystals. Along the side of this outcrop, about a hundred and fifty feet east from this spot, and a little higher up the hill, is another vein and pocket that I have worked about six inches thick and but little exposed, as around it is dirt and grass. The opening is about a foot and a half long, and in it many fine crystals still remain, of fair size and great beauty.

As there are a number of other minerals in the first-mentioned vein, I will notice the characteristics of this mineral again: Specific gravity, 2·6; hardness, 6. The form is tables, with sharp edges and often thick prisms. Before the blowpipe it is unaltered; but as it here contains a fair proportion of soda, the flame from it has an intense yellow color, which is characteristic of that base. It is not acted upon by the acids. The color is a gray, slightly dirty or yellowish, and the crystals are more or less perfectly translucent. Groups of this mineral are very handsome, as the crystals are set together, especially those from the last-mentioned vein, in confused piles, resembling the ruins of a stone building and other similar forms.

Calcite.—This mineral is abundant in the first-mentioned vein, and large perfect crystals may be readily obtained, both of a pure white color and of a darker shade, but perfectly transparent. Some of these crystals are an inch in diameter, and also fine groups of smaller ones. These crystals frequently contain numerous slender crystals of asbestiform actinolite, about a quarter or half an inch long, of a pure gray color, and fibrous, like asbestos. Sometimes a small mass of even perfect crystals of calcite may be obtained, containing a number of these sword-like groups, and are thus beautiful specimens. I have obtained a number of these, as have others, and they are comparatively abundant in the white calcite. It is rarely that this is found in this unique position, and thus its value is considerable. They are not conspicuous, but must be searched for among the loose rock cut out near the vein.

Pyroxene.—There is a little of a spongy fibrous mineral, a variety of pyroxene, like asbestos, in and around the vein, of a light brown color and fine short fibers, very tough, but not like true asbestos. It may be obtained in abundance and labeled "asbestos," for want of a better name. It is readily fusible in fibers, and insoluble in acid. Its specific gravity is about 2·3; hardness, probably 5.

Galena.—This mineral, so common in certain parts, is extremely rare from the vicinity of New York city, but occurs sparingly in the feldspar in this vein. It is readily recognized by its appearance, which is cubes or right-angled forms, of a dark lead color, and resembling that metal. It occurs here in crystals of about a quarter or three-eighths of an inch in diameter, and is not conspicuous. It is peculiar for this locality, as I before noticed, and that is its only value, governed more or less by the taste of the mineralogist finding it. Specific gravity, 7·6; hardness, 2·5. Before the blowpipe it decrepitates if not cautiously heated, fuses, giving off fumes of sulphur and leaving a globule of lead, of which it is a sulphuret.

I might mention here that the rare mineral, sphene, also occurs in extremely small quantities, but would not be recognized except by an expert or one familiar with it.

Stilbite.—This mineral occurs in large beds in the lower quarry and of a light brown color, otherwise possessing the characteristics mentioned in my description of it under "Weehawken Tunnel." There is a large quantity spread over the loose rock in the extreme eastern part of the quarry, and the crystals are not over a quarter or an eighth of an inch long and standing out on the rock. There need be no difficulty in obtaining a large supply of fine specimens of this mineral, as it is very abundant and readily obtained, which would be nearly impossible if the rock was in place.

Epistilbite.—This very rare mineral is quite abundant in this same pile of loose rock, and is very unique. It is in pure white or pearly forms, very thin and close on the rock, set diverging around a central point. Its characteristics other than these are impossible to obtain by the means at hand, but as it occurs alone or with the stilbite, which is darker-colored and set perpendicular on the rock, while this species is laid flat upon the rock, it is a rare mineral and well worth securing as a cabinet specimen. As the minerals of this locality are so individualized, it will be unnecessary for me to sum them up in a table and point out their characteristics.

THE IRON MINES.

The third locality are the four iron mines, which contain minerals of interest. I will detail them in the order in which a trip might be made to include them all, and will so word my details as to suppose that we are going the trip together, which will make it much plainer; otherwise a course may be mapped out to suit the time and interests. A horse and carriage will be necessary if one is not a sufficiently stout pedestrian to walk the eight miles between them and to the ferry for New York city. An afternoon from twelve o'clock will be necessary in order to arrive back by seven o'clock in the evening, spending about four or five hours in the field, as an examination into the details of working the iron mines and washing or preparing the ore will be interesting, and I will add a few words of explanation.

We start on the north shore ferry boat of Whitehall street, New York city, at 12:30, and enjoy a sail down to Port Richmond, where we land and procure a buggy to start for the mines. We go east upon the shore road from the ferry to Jewet avenue, which is just this side of the bridge, and turning up that road we travel in a direct line the mile and a quarter to the mine on Kirk's property, just before reaching the corner of the Richmond turnpike. It is known by the large heaps of ore in the lot, which is on the east side of the road and entered by the ore gate, which stands open. We drive in here and, fastening the conveyance, seek the superintendent, Mr. Smith, in the pit south, who is a well-experienced iron man and will take us around through the galleries, which are perfectly dry and level with the bottom of the pit, and explain the beds of ore and their working.

The ore is a limonite or hydrous sesquioxide of iron, and contains masses of what we term shot ore, a mass of which is desirable as a specimen, the small dark round globules in a light-colored gangue being very pleasing to the eye. Asbestos may also be obtained here; and in the old pit on the adjacent property, now nearly filled with water, the finest quartz crystals occurring within many miles of New York are to be obtained, being in pockets on the serpentine under the iron; they are in geodes and groups of remarkable size, and Mr. Smith has a large collection of them. They may be obtained by digging a foot or so to the rock and having the luck to strike a fine pocket, in parts that Mr. Smith might show. They are beautiful cabinet specimens, and this locality is not generally known.

The many colors and grades of soft ore is to be obtained in the pit now working, of every color and shade, from yellow to black, and the earthy oxide of manganese is very abundant. The ochers and siennas, peculiar colored limonites, occur in great variety, and may be obtained readily. Behind the pit and up near the engine house, we find the washer for

washing the dirt and clay from the ore, and also the settling tanks and driers for preparing ocher.

Having seen all that is of interest and obtaining some varieties of soft ore, etc., and some quartz crystals, we say good-by to Mr. Smith, and driving down a lot further, turn to the east (left), up the Richmond turnpike, which we go along until we reach a point between the first road going south from the turnpike after we pass the little Moravian church, and the road that commences in front of the church; a quarter mile east of Kirk's, on the right side of the turnpike, near the fence, and about a hundred feet west of this upper road, here is a large mass of iron ore, and from it small but beautiful quartz crystals may be broken, and some finely colored hard ore or hematite be secured. We procure considerable of the former and some (if we feel disposed to do so) of the latter, which will be met with again in the other mines, however; and going back along the turnpike to opposite the Moravian church and turn down (south) the road commencing there, along this we go for about two miles and a quarter until we come to the mines on Toat hill, where there are very extensive surface cuttings and constitute two mines or rather companies.

The ore here is hematite and it occurs in every imaginable form, some of great uniqueness, such as a fringe, a statue of a man, a gridiron, knife, grottoes, geodes, grotesque figures similar to what we sometimes see fabricated from ginger cake, etc., and innumerable others; they may be picked out of the diggings by the ton if necessary, and these unique forms are very plentiful. The before-mentioned Mr. Smith has among his collections a great number of these, and they are well worth securing and possessing.

We will also examine the washing process, of which both the cylinder and gutter are used, and the manipulations employed to save and use the wash-waters over and over again, and then, after spending a most pleasant hour, start back in the same direction which we came as far as what is termed Ocean terrace. This crosses the road, upon which we come about two-thirds way back, and right on the top of the first very high hill south of the turnpike, at a point where a fine view may be obtained of Newark Bay, New Jersey, etc.; we turn in this and travel to the right (east) along it until we arrive in the Towle mine.

Here we will find a large area of surface cuttings and some fine specimens of quartz and the fine forms of limonites, hard as 6, and of a pure black color, looking like cast iron, but darker, covered with what resembles asphaltum varnish, but is oxide of iron. The structure of these forms will be found, on breaking them, radial within and very beautiful. They may be found near the road in single bowlders, covered with small quartz crystals and like the forms we before met on the turnpike; we will secure a good supply of choice crystals or forms of these, and driving down to the Clove road, and thence north by west a short distance to the Serpentine road, which is the first one starting north on that side of Clove road. On this Serpentine is a cutting for iron ore in which we may spend a well-repaid hour and find many beautiful forms and colors of iron ores and asbestos.

We then drive back to the Clove road and along it and the left hand branch from it, commencing at the property of J. Menzanedo, when about a mile along it, and this will bring us out just a hundred feet west of where we first found Jewet avenue, up in Port Richmond; or, instead of this, we might continue up the Serpentine to Grimes Hill, thence to Eakens and Pavilion, and after examining them, as I explained in the beginning of this part, get the boat at the south shore landing, either third, second, or first; or, if this locality is reserved for another trip, go back to the Clove road, turn east on it and its continuation, Oak street, a quarter of a mile to Vanderbilt avenue, and north along that for two miles to the third landing.

The localities for Part III. will be Hoboken, New York Island, and the few others a short distance from the cities.

THE HORTICULTURAL EXHIBITION AT PARIS, MAY, 1882.

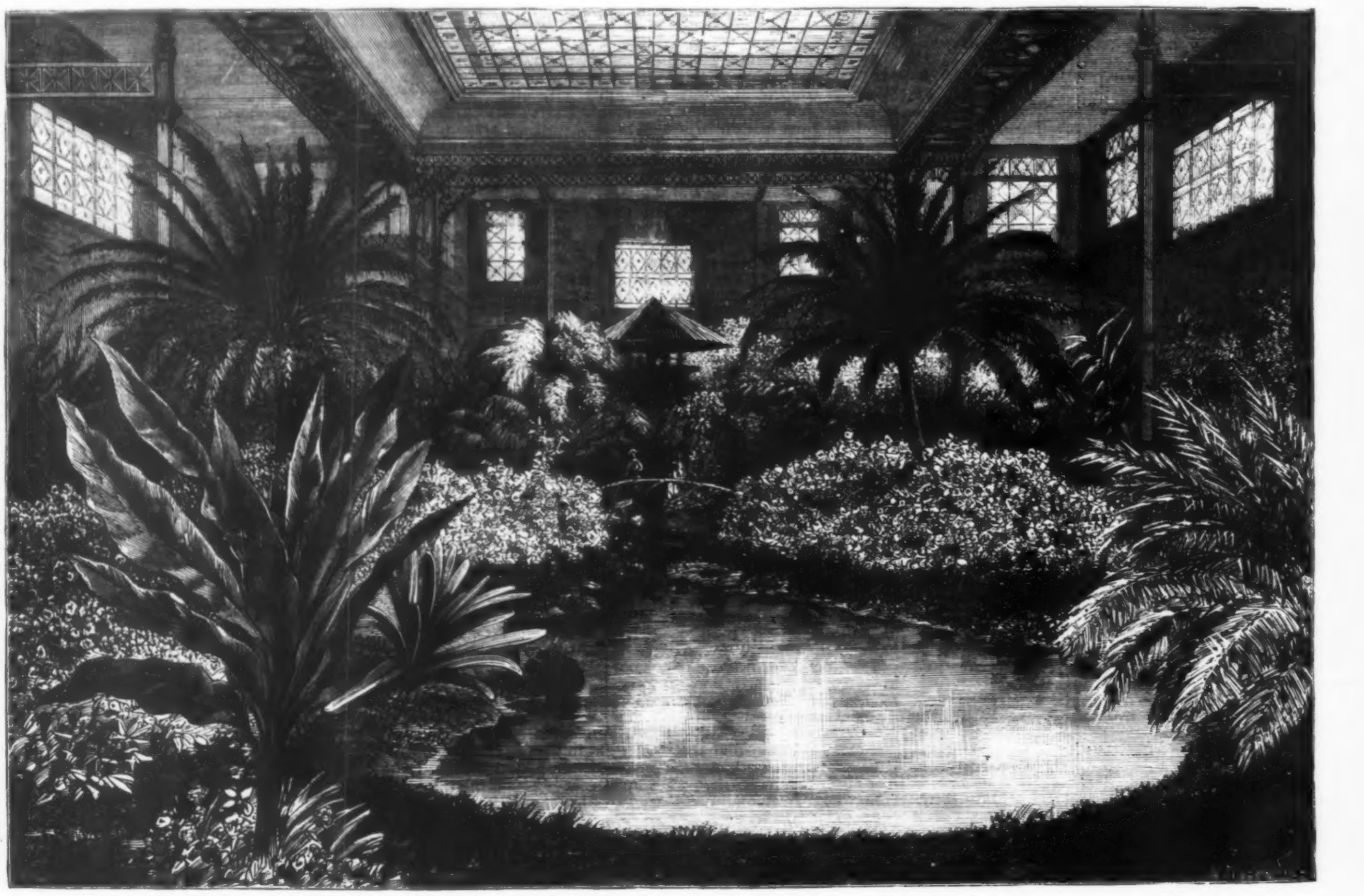
THIS Exhibition, held at the end of the month of May, was very successful, and deservedly so. It was organized by the National and Central Horticultural Society of France, and was held in the grand pavilion of the Universal Exhibition of 1878—that vast glass structure having been placed at the disposal of Mr. A. Lavallée, the president of the Horticultural Society. The general plan of the Exhibition was designed and carried out by Mr. Ed. André.

The principal entrance opened on a narrow avenue edged with borders of large plants in boxes, such as laurels, pomegranates, bamboos, etc.

The principal collections were shown in the large city pavilion. The basket of tuberous begonias from Messrs. Couturier & Robert, of Chaton, in the first place, attracted attention through the size of their flowers, some of which measured no less than 12 centimeters in diameter. Palms from Mr. Dallé, double petunias from Mr. Naudin, and some pelargoniums from Mr. Poirier also successively attracted attention.

Mr. Louis Leroy, a member of the jury, has published in the *Revue Horticole* a complete account of the principal collections exhibited, and from this we borrow a few details.

Messrs. Thibaut & Keteleer showed a fine lot of orchids, and, among them, *Oncidium concolor*, *Cymbidium lowii*, *Odontoglossum prænitens*, the rare *Pilumna fragrans*. A neighboring collection, that of Mr. Lüddemann, showed us, elevated in the midst of surrounding verdure, *Vandas*, *Cottleyas*, *Cypripediums*, *Oncidiums*, *Selenipediums*, etc., all in perfect health, and in an excellent state of culture.



VIEW OF THE EXHIBITION OF THE HORTICULTURAL SOCIETY OF FRANCE.

In front, there was an admirable collection of hothouse plants from Mr. Savoye, and against the wall were arranged rhododendrons, azaleas, and kalmias from Mr. Croux, forming a splendid sight, where color truly ran riot.

The collection of Messrs. Chantrier was not so large, but it was exquisite. Among the wonderful crotons displayed by them was *C. musaicus* and another novelty as yet unpublished—*C. mortefontainensis*—a plant of the first rank that at present cannot be surpassed.

Among Mr. Chantrier's plants there was blooming the most beautiful specimen of *Anthurium andreanum* that has ever as yet been seen in France. The plant bore six spadices in flower at the same time, with beautiful scarlet spathes, which were even larger than Mr. André had ever seen in New Granada. At the base of the rock-work, on the grass-plat, the rhododendrons from Mr. Moser, of Versailles, well sustained the reputation of that establishment, and were surrounded in their turn by the hothouse collections of Messrs. Saison-Lierval, Landry, and Morin, wherein culture of a superior order was revealed.

The large mound of rock-work was entirely devoted to palms, ferns, and cycads from Mr. Chantin in very large specimens. The grand prize of honor was awarded this superb collection, in which were remarked several unique specimens, such as the Cycad *Katakidozamia maclayi*.

A group of clematis, with large flowers, twining around an iron column, likewise attracted much attention.

Returning toward the entrance, through the other grand passage of the pavilion, there were met with some elegant ferns from Mr. Landry; brightly-colored and variously-shaded large gloxinias from Mr. Duval, of Versailles; and a small but exquisite lot as regards selection and culture from Mr. Truffaut.

Next came an admirable lot of roses, ticketed Lévêque, of Ivry. It was an enormous mass, an amphitheater, an avalanche of fresh and perfumed flowers; among which there was a new variety that has been dedicated to Mr. Léon Say, Minister of Finances, as a *souvenir* of his presiding over the exhibition banquet.

On leaving the pavilion through the western door, there might be seen a garden in the French style, which was improvised within two days upon an old macadamized road. This was ornamented with grass-plats, vases, borders planted with pinks and pansies from Mr. Falaise, and annual plants and gigantic daisies (*Chrysanthemum frutescens*) of over two meters in diameter.

In the middle of this garden there was a tent of 700 square meters containing real vegetable treasures. Here were roses in pots, in large, admirably selected clusters, from Mr. Margottin, Jr., who likewise exhibited a very choice collection of long-stemmed roses, and vines in pots, covered with superb and appetizing grapes. These latter, fully ripe, are now selling at sixteen francs per kilogramme, and the entire quantity here exhibited represented a value of more than one thousand francs. Following the passages in the tent there were met with various forced fruits, such as peaches, apricots, melons, pineapples, and cherries, from Mr. Fontaine; then, in the center of the tent, some dracænas from Mr. C. Lemoine, with their various shades of green, red, violet, and salmon. Innumerable cut flowers, including ranunculuses, anemones, irises, and muscarises; annual plants of superior culture from Mr. Lecaron; cactuses from Mr. Eberlé; and a collection of Japanese maples from the museum went to make up the *ensemble* of this tent, which was so full of interest.

From the tent the visitor, after casting a glance at a curious specimen of Mosaïculture from Mr. Comesse, and over another tent that contained cut peonies and roses from Mr. Lévêque, entered the park. The open ground was covered principally with magnificent lots of coniferæ from Messrs. Croux, Paillet, and Defresne; agaves from Mr. Chantin, and a numerous and well-cultivated collection of country perennials from Mr. Yvon.—*La Nature.*

HORTICULTURAL SUGGESTIONS.

Culture of Quinces.—The best quince trees which we have seen grow on good, rich, upland soils, moderately manured and well cultivated. Owners differ as to the best soils, some insisting that low and naturally damp land is the best, while others prefer the reverse. During the discussions at a meeting of the Western New York Horticultural Society, C. L. Hoag, of Lockport, who is a successful cultivator, said that quince trees drop their leaves if planted on low grounds, whatever might be the cultivation given them, but hold them well on upland. On the other hand, E. A. Bronson, of Geneva, well known also as a skillful cultivator, said that according to his observation the leaves drop from trees growing on upland, but adhere well on low, moist ground. Some succeeded best with them in grass, others on well-cultivated soil. So doctors differ. Among the most successful trees which we have seen were those on good upland soil in the vegetable garden of Robert J. Swan, of Geneva, N. Y. They were twelve or fifteen years old, four or five inches in diameter, and eight or nine feet high. The ground was well cultivated, and small mounds of coal ashes were placed about them to exclude the borer. Some of the trees have borne two bushels, and one year a hundred bushels

were picked from the sixty trees. These were the Orange quince. Rae's quince, on the grounds of Ellwanger & Barry, at Rochester, which have borne heavily, are many years old, and some are ten or twelve feet high. They grow on upland, have received good cultivation, and the ground has an annual moderate top-dressing of manure. From the little we have seen of the Champion quince, we are led to regard it as a very promising variety, and it may prove the best known. The quince is too often quite neglected, and allowed to grow into a mass of unpruned brush, and to become encumbered with grass and weeds. Nurserymen raise straight and handsome trees, which do best if the heads are formed within a foot or two of the ground, with a single straight stem. If the young trees happen to be crooked or stunted, they may be improved by cutting down to a bud or new shoot, and a vigorous stem will spring up, and form a straight tree. If this new tree does not incline to grow sufficiently erect, it may be made so by tying to a stake. The cutting back and pruning must of course be done before the buds swell in spring. The principal disease affecting the quince is the twig-blight. There is no certain remedy, but it is always well to cut off and burn the dead portions. The borer attacks the stem near the ground, and when seen is to be treated the same as the apple borer.

Budding.—Peach trees, if in a thrifty condition, may be budded for some weeks to come, or as long as the bark will lift freely from this year's wood. If the bark adheres, it is useless to attempt budding any kind of trees. Buds of any kind inserted two weeks ago, more or less, should have the ligatures removed. Most kinds of fruit trees have nearly ceased growing, and will not be likely to bud successfully, except peaches, mahalebs, and quinces for dwarfs.

Weeds are apt to be neglected late in summer. Clear them out thoroughly, and prevent any from dropping their seed for another crop next year, and observe how much easier it is to prevent their growth at all by frequently stirring the surface.

Pruning out the useless wood of young trees may now be done without check to the trees, as they have nearly ceased growing, and little harm will now result to them.

Blight and Black-knot.—Cut away promptly, on the first appearance, any limbs or shoots of the pear and plum affected with these diseases. The pear may not be cured, but excision will do no harm; the knot may be kept off the plum with entire success, if promptly attended to.

Early Pears must be gathered at least a week before the period of full maturity and ripened in the house. This care is absolutely necessary for all sorts which are apt to be core-rotten.

Seeds in the kitchen garden should be promptly gathered, and when dry enough packed in papers or otherwise, marking the name and year.

Manure.—The autumn application being often or generally the best, collect together all the materials practicable and have them well incorporated for future use. Young fruit trees, or older ones, which do not grow fast enough, should have a broad dressing of manure on the surface of the ground, to become gradually washed in by autumn, winter, and early spring rains.

Strawberry Beds, planted late in summer, after sufficient watering of the plants, should have the ground about them covered an inch or two deep with fine manure, to preserve the moisture of the soil and enrich it. The sooner they are set the better, that new roots may hold them well to the soil. But—

Potted layers need not necessarily be set so early if the weather happens to be very dry, and the roots have not sufficiently filled the pots. When set out keep them well soaked with water for a time, if needed.

Blackberry Bushes which have done bearing, and will die out in time, may be cut away to allow the stout young canes for the next season's bearing to thicken and become strong.

Raspberry Bushes may be treated in the same way, but as they are not such strong growers more time should be allowed them fully to cease growing. The tips of the capberry bushes may not be buried for new plants.—*Country Gentleman.*

HOW ANIMALS BECAME CARNIVOROUS.*

In the scale of creation plants were developed first; they began as very low forms, or may even all have sprung from one low form. As time went on they grew in number and variety. Some slight circumstance was sufficient to cause one to change its character, and it handed down its peculiar character to its offspring. In this way fresh varieties of plants were formed, and now we have an immense number of all sorts. Some are content to carpet the fields like the daisy, while others thrive best by shooting up into the air like buttercups, but each one has assumed its present shape by finding that it could so get on best. These changes were not made in a few years, but are the works of centuries, and if any one could have watched them he could scarcely have been able to tell where a change began, so minute were the differences. After the plants had appeared—or almost at the same time—the lowest forms or animal life appeared and fed on the plants. These low forms of animal life had also to differentiate themselves by some stress of circumstance, and in time new kinds of animals were the result. Some insects were forced by stress of circumstances to feed on each other; they did this for some time; their organs changed in structure, and in time it became right for them to feed on carcasses.

We see an everyday example of this in the midge; it sucks the blood of animals if it can get it; if not it feeds on the sweet juices of plants. The leech is also another example: it feeds on vegetable food in the pond in which it lives, but it will live on the blood of an animal if it can get it.

No doubt at one time animals were herbivorous, but some stress of circumstance made them feed on the bodies of one another until they developed certain peculiarities, and hereafter it was right for them to do so, and now they are called carnivorous animals. Let us instance many goats on an island; they increased in number until there were more goats than there was food for them—this is now a recognized law. Some died of starvation or in the fight for food; one was very hungry, and tearing off the skin it eat the flesh of its fallen kin. The flesh appeased its hunger, and when hungry it again returned to the carcass, and thus it went feeding on dead bodies. After a time it began to like flesh, and when it could not get dead bodies, then it killed its kind and fed on them. The offspring of this animal would tend to do the same, and since it has to fight for its living it has to grow new parts. Its teeth must change, its limbs must also change, and the character of its stomach must alter. After a few centuries we find a different animal from the original goat; in fact, we have now a carnivorous animal. From this instance you see how changes may occur. Some one may say that goats could not be taught to eat flesh, but experiment has shown that goats and sheep, or any animal, can be taught to eat flesh until it refuses its natural grass, hay, or corn.

A change of this nature has been lately seen in New Zealand. In the memory of man the kea or *Nestor notabilis* was a fruit-eating parrot. Sheep were introduced into New Zealand, some of them died, and the kea tearing off skin eat some of the flesh. It liked it and began to feed on flesh only. Now, as dead sheep were not always to be had, it attacked living sheep; killed them and fed on their bodies. The kea is now a carnivorous bird, and in consequence is killed wherever found. Man himself has tried to be carnivorous or partly so. His original dwelling place was in a hot country where he had fruit all the year round. He increased rapidly, and to find food emigrated to places where fruit was only ripe once a year, so that he could only live on it for about six months. In winter he killed animals for food, and found that by eating their carcasses he could live until the summer came round. He found hunting hard work, so he tamed the young of the cow and the sheep, and killed them when he wanted them. This has now gone on for ages, and man has begun to think that a mixed diet suits him best. But for all his carnivorous practices he has not changed his nature yet; his teeth, tongue, stomach, length of intestine, flat nails, and perspiring skin, all point to his frugivorous character. That such is his nature seems beyond dispute, and that men can live without flesh food is now an everyday experience. There are hundreds of men now living in England who never eat meat from year's end to year's end, and they are as strong as other men and remarkably free from disease. Let readers ponder over this, try and live without meat, and they will soon come to the conclusion that man has no carnivorous traits.

* By T. R. Allinson, L.R.C.P., etc., in the *Field Naturalist.*

THE POMPANOES.

Among the comparatively recent additions to the fish supply of our northern markets are the Pompanoes, four species of carnivorous fish allied to the mackerels. In the Bulletin of the Fish Commission, Prof. G. Brown Goode gives the following information touching the character, occurrence, and importance of these fish:

There are four species of Pompano in the Western Atlantic, very similar to each other in general appearance, but easily distinguished by differences in proportion and in the number of fin rays.

The commonest species, the Carolina Pompano (*Trachynotus carolinus*), has the height of the body contained two to two and two-thirds times in the total length. The length of the head, five to five and one-third times, one of the caudal lobes four times; it has twenty-four to twenty-five rays in the second dorsal, while the anterior rays of the true dorsal and anal fins, if laid backward, reach to the middle of the fin.

The Round Pompano (*T. ovatus*) has the height of the body contained two to two and one-third times in the total length; the length of the head, five to five and one-fourth times; one of the caudal lobes, three and a half to four times. In the second dorsal are from eighteen to twenty-one rays; in the second anal from sixteen to nineteen, while in the Carolina Pompano there are twenty-one to twenty-two.

The African Pompano (*T. goreensis*) resembles in general form the Round Pompano, though somewhat more elongate, while the head is larger, being contained four and a half times in the total length. The anterior rays of the dorsal and anal extend beyond the middle of the fin, if laid backward. In the number of the fin-rays it corresponds most closely with the Round Pompano.

The Banner Pompano (*T. glaucus*) has a somewhat elongate body and a small head. It is much thinner than either of the other species. Its silvery sides are marked with four blackish vertical streaks; the best distinguishing mark is in the length of the first rays of the dorsal and anal, which extend back nearly to the tip of the caudal fin. The name Pompano, applied in this country to all of these fishes, is a Spanish word, meaning "grape leaf." The word in Western Europe is applied to a very different fish.

THE COMMON POMPANO.

The Common or Carolina Pompano (*Trachynotus carolinus*) occurs in both the Atlantic and Pacific waters of the United States. On our eastern coast it ranges north to Cape Cod, south to Jamaica, east to the Bermudas, and west to the Gulf of Mexico—at least as far as the mouth of the Mississippi River.

In our New England and Middle States it is a summer visitor, appearing in June and July and departing in September. Although it is at present impossible to ascertain the lower limit of its temperature range, it is probable that it corresponds very nearly to that indicated by a harbor temperature of 60° to 65°.

This species, like the Round Pompano, was described by Linnæus from South Carolina, and never had been observed in any numbers north of Cape Hatteras until the summer of 1854, when Professor Baird discovered them near Great Egg Harbor. In his "Report on the Fishes of New Jersey," he states that he had seen them taken by thousands in the sandy coves on the outer beach of Beesley's Point. These, however, were young fish, few of them weighing more than half a pound. In 1863 he obtained both species in Southern Massachusetts, where in subsequent years they have been frequently captured.

"My first acquaintance with the Pompano (New England)," writes Professor Baird, "was in 1863, during a residence at Wood's Holl, where I not unfrequently caught young ones of a few inches in length. I was more fortunate in the summer of 1871, which I also spent at Wood's Holl; then the Pompano was taken occasionally, especially in Captain Spindle's pound, and I received at different times as many as twenty or thirty, weighing about 1½ pounds or 2 pounds each. Quite a number were caught in Buzzard's Bay and Vineyard Sound in 1872."

It is a fair question whether the Pompano has recently found its way into northern waters, or whether its presence was unknown because nobody had found the way to capture it. When Mitchell wrote on the fishes of New York in 1842 he had access to a single specimen which had been taken off Sandy Hook about the year 1820.

The spawning times and breeding grounds of these fishes are not well known.

Mr. S. C. Clarke states that in the Indian River they spawn in March, in the open sea, near New Smyrna, Fla. It is supposed that those visiting our northern coasts breed at a distance from the shore. The eggs, like those of the mackerel, being lighter than the water, float at or near the surface. The Pampanoes may, however, be truly migratory, seeking the waters near the equator in winter, and following along a coastwise migration, north and south, in summer. They are rapid, powerful swimmers; their food consists of mollusks, the softer kinds of crustaceans, and, probably, the young of other fishes. S. C. Clarke remarks that they have been known to bite at a clam bait. Genio Scott remarks: "It is mullet-mouthed; never takes a bait except by mistake." Their teeth are very small, and are apt to disappear with age. As seen in the New York market they rarely exceed 5 pounds or 6 pounds in weight. I quote in full the observations of Mr. Stearns:

"The common Pompano is abundant on the Gulf coast from the Mississippi River to Key West, and, as far as I can learn, is rare beyond this western limit until the Yucatan coast is reached, where it is common. It is considered the choicest fish of the Gulf of Mexico, and has great commercial demand, which is fully supplied but a few weeks in the year—namely, when it arrives in spring. The Pompano is a migratory fish in the Pensacola region, but I think its habits on the South Florida coast are such that it cannot properly be so classed.

"At Pensacola it comes in to the coast in spring and goes away from it in fall, while in South Florida it is found throughout the year. In the former section it appears on the coast in March in schools varying in numbers of individuals from fifty to three or four thousand, which continue to 'run' until the latter part of May, when it is supposed that they are all inside. Their movement is from the eastward, and they swim as near to the shore as the state of the water will permit, very seldom at the surface, so as to ripple or 'break' the water, although sometimes while playing in shoal water they will jump into the air.

"Before any schools enter the bays certain ones will remain for days, or even weeks, in a neighborhood, coming to the beach during the flood-tide to feed on the shell-fish that abound there, and returning again to deeper water on the ebb-tide. The holes or gullies in the sand along the beach are their favorite feeding grounds on these occasions. Sharks and porpoises pursue the Pompano incessantly, doubtless destroying many. The largest numbers come in April, and sometimes during that month the first schools are seen entering the inlets, others following almost every day until about June 1, when the spring 'run' is said to be over. Every year they appear in this way at Pensacola and adjoining bays, although there are many more some years than others. As the abundance is judged by the quantity caught, I think that the difference may lie more in the number of fishing days (pleasant ones) than in the real numbers of fish present. The sizes of Pompano that make up these schools are large or adult fish averaging 12 or 14 inches in length, and small fish (probably one year old) averaging 8 inches in length. The largest Pompano that I have seen measured 19½ inches in length, and weighed 6½ pounds, the extremely large fish called Pompano, of two or three times that size, probably being another species. After entering the bays the schools of Pompano break up, and the fish scatter to all parts where the water is salt and there are good feeding-grounds. Except single individuals that are taken now and then, nothing is seen of Pompano until late in the fall, when they are bound seaward. In regard to its spawning habits, nothing very definite has been learned. It has spawn half developed when it arrives, and has none when it leaves the bays. Large quantities of the fry are seen in the bays all summer, which is some proof of its spawning inside. In June, 1878, I caught specimens of the fry, varying in size from three-quarters of an inch to 3 inches in length. Very many schools of these sizes were also observed in July and August, of the same and following years of 1879-80.

"The schools of fry go to sea in August and September. The older or adult fish leave the coast in September and October in small schools that are only seen and caught at the inlets where they happen to cross shoals or follow the beach. These Pompano of the fall are very fat and in every way superior to those caught in the spring. As before mentioned, the Pompano is found on the South Florida coast all the year. The sea beach from Tampa Bay to Charlotte's Harbor seems to be its favorite feeding ground, owing to the quantity of shellfish that occur there. It does not form in large schools as in the Pensacola region, and therefore is not taken in such large quantities by seine fishermen.

"Smacks from Mobile and Pensacola sometimes go to Tampa Bay for them. I have been told that Pompano are caught at Key West in considerable quantities by hook and line, and I have known of a few being taken in that manner at Pensacola. It feeds entirely upon small shellfish, which are crushed between the bones of its pharyngeal arch."

THE ROUND POMPANO.

(*T. ovatus.*)

The Round Pompano (*T. ovatus*), sometimes called the Shore Pompano, is at Pensacola known by the name "Gaff-topsail," and in the Bermudas by the name "Alewife." This fish is very often confused by market-men with the Carolina Pompano, and I have seen them sold together under the same name in the Charleston market, just as I have seen the young of four species of the herring family sold indiscriminately in New York.

The Round Pompano is cosmopolitan in its distribution, occurring in the North and South Atlantic, in various parts of the Indian Ocean, and on the coasts of California and China. The young have been obtained in the harbor of Vineyard Haven, Mass. It is probable that the species is far more abundant in our waters than we now suppose it to be. Stearns remarks that it is obtained occasionally at Pensacola with the other species, but is never very common; is seen only in the spring, and is not valued as a food-fish. About the Bermudas they are sometimes very abundant, and in 1875 a school of them, numbering 600 or 700, was seined on the south shore of the islands. They are there considered most delicious fish.

THE AFRICAN POMPANO.

(*T. goreensis.*)

This species was originally described from the island of Gorea, on the west coast of Africa, and was observed by the writer in 1876, and in 1877 was discovered in Florida. It is the largest of the Pompanoes. Two or three specimens, weighing from 15 pounds to 20 pounds each, have been sent from Florida to the New York market. One of these, taken at Jupiter Inlet, was sent by Mr. Blackford to the National Museum. In the Gulf of Mexico it is not unusual, being known at Key West as the "Permit."

Stearns remarks:

"This fish is rather common along the lower end of the Florida peninsula, specimens being caught quite often in seines at Cedar Keys and at the mullet fisheries of Sarasota and Charlotte's Harbor, and also at Key West. It is said

to attain a considerable size, 15 or 20 pound specimens being common. It is not a choice food-fish when so large, and even smaller ones are comparatively dry and tasteless. I have not found it north or west of Cedar Keys."

THE BANNER POMPANO.

(*T. glaucus.*)

This species is a member of the West Indian fauna, and occasionally occurs at the Bermudas; it has lately been noticed on the Pacific side of the Isthmus of Panama.

ON THE INFECTIVENESS OF TUBERCLE, WITH SPECIAL REFERENCE TO TUBERCULAR CONSUMPTION.*

By WILLIAM PIRRIE, M.D., LL.D., F.R.S.E., Professor of Surgery in the University of Aberdeen, Consulting Surgeon to the Royal Infirmary of Aberdeen.

As it is customary at these annual gatherings for the president to bring before the associated members some topic of medical or surgical interest, I have thought it would not be unprofitable to dwell for a few minutes on some of the researches in later times on the etiology of tuberculosis, as they tend to enlarge our conceptions of contagion; to correct many previously held doctrines regarding tubercle; to establish a substantial claim of contagiousness for that widespread and awfully fatal malady, consumption; to reveal to us its specific contagium or specific infecting medium; and to explain the facility with which it can be spread in a community. It has been said that one-seventh of all the deaths throughout the world and one-third of the deaths in active middle life are caused by tubercular disease. If this is correct, it must be all-important to be familiar with every addition to our knowledge of this important subject. The elaborate investigations carried on during the last few years regarding the etiology of infective diseases are of the highest interest to the practical surgeon and the sanitarian; but I intend on the present occasion to limit my remarks to the subject of the infectiveness of tubercle, perhaps the chief source of consumption, which is the commonest and most fatal manifestation of tubercular disease; and, as bearing on this important subject, to draw attention to the researches of recent experimental physiologists, ending with the remarkable discoveries of Koch, formerly of Breslau, and now chief of the Imperial Health Department of Berlin. Without going so far as Laennec did in his belief that phthisis is always tubercular, yet, if we grant that this widespread and fatal disease is in the main of tubercular origin, we cannot over-estimate the researches on the infectiveness of tubercle, which must greatly influence the therapeutics of those who believe in them.

It is not my purpose to consider whether the two processes now called by the separate names of the scrofulous and the tuberculous are really identical; nor to enumerate all the opinions promulgated on the pathology of phthisis; nor to review the facts advanced in support of the opinion that the little nodular growths, composed of giant-cells and a branched reticulum, and to which the name tubercle is now commonly limited, are always due to primary non-specific inflammatory action; but rather to trace recent experimental investigations with a view to showing how they prove that consumption is due to an infective process, and some of them to afford demonstrative proof of the morbific agent which so injures the pulmonary tissue as to lead to its subsequent consolidation and ulceration. They seem to justly claim for consumption the character of infectiveness arising from a special parasite. The contagiousness of consumption is not, however, promulgated for the first time in our own immediate day, nor even in the recent past, for in all ages, probably, some have held this belief. Thus Galen believed in its contagiousness, and ordered consumptive patients to inhale the vapors from the crater of Etna, while Morgagni, in his day, was of the same opinion. We read also that this belief has always prevailed in Italy, Spain, and other countries of Southern Europe. In our country and day many great men have denied this doctrine, while some have specially promulgated it. Thus, looking back on the more recent past, we find the late Dr. William Budd, of Bristol, thirty years ago, as the result of clinical observation, expressing the opinion that pulmonary consumption was allied to the eruptive fevers, and differed from them only in its degree of virulence, and consequent rate of progress. He entertained no doubt in his own mind that it is of a highly contagious character; that its virulence in any country is in the inverse ratio of its duration there, being most rapid and fatal on its first introduction, and becoming, by long continuance, as in our own country, of a milder type and more chronic character. Thus we are told that when first introduced into the Sandwich Islands it sometimes proved fatal in less than six weeks; and we are all familiar with the fact that it often drags on, in our own country, a slow and at times intermitting course, extending over months or years. Still, these views of Budd obtained but few adherents, for the great bulk of physicians, dependent solely on clinical observation and practical experience, were decidedly of opinion that consumption could not be spoken of as a contagious disease in the same sense as the ordinary eruptive fevers are. Within later years, however, much has been done to give us more enlarged and precise views on the subject of contagion, and much that mere practical experience and clinical observation could not determine has been solved, and made matter of demonstrative proof by recent experimental investigations.

Now, if we assume, as already remarked, that consumption is, in the main, tubercular, its widespread diffusion is easily accounted for by the results of these researches and experiments, which, at the outset, proved that there was something in tubercle which possessed infective properties, and have culminated, in the hands of Koch, in making the special contagium, or the precise infecting organism, a matter of demonstrative proof.

About twenty years ago Buhl taught that acute tuberculosis was of an infective nature, and was owing to the existence of a primary inflammatory induration which had become caseously degenerated, and to the absorption of particles from the caseous mass. His view was that the infective substance was always associated with the secondary caseous change; but recent experiments on the artificial induction of tuberculosis in animals render this view untenable.

In 1865 Villemin commenced a series of experiments to prove that tubercle was an infective disease, and demonstrated the fact that caseation of the tuberculous matter was not necessary to constitute it a focus of infection. He took little bits of tuberculous matter, about a pin's head in size, from the body of a man, or a cow, or rabbit, and inserted them under the skin of the ears, groins, or other parts of dogs and rabbits. The result was that the wound at first healed, but afterward became red and swollen, and ultimately ulcerated, owing to the development of a tuberculous mass. If these animals were killed after fifteen days from the date of inoculation, a caseous mass, surrounded by small yellow granulations, was found at the seat of the wound; tubercles were found in the viscera, especially in the lungs; and, besides gray granulations, infiltrated masses of tubercle were discovered in varying conditions, according to the date of the animal's death. He found like changes to occur in instances where he injected hypodermically small quantities of the sputa of consumptive patients, mixed with water.

Chauveau of Lyons obtained like results from all his experiments, which were of three kinds. First, he gave some oxen, by the stomach, portions of tuberculous matter got in some instances from man, and in other cases from oxen, which are very prone as a class to what is known by the names of "pearl disease," "angle berries," or "grapes," from the peculiar condition of the serous membranes, or, generally, bovine tuberculosis; second, he inserted particles of tuberculous matter into the connective tissue; and, third, he injected into the veins water into which tuberculous matter had been placed and had been filtered. In all cases tubercle granulations were found in the lungs, and all the animals contracted tuberculosis.

We may here conveniently mention that Dr. Charles Creighton, in his interesting work on bovine tuberculosis in man, published last year, describes numerous cases in which a condition of organs in the human subject was found similar to that seen in oxen dead of tuberculosis; and he establishes the extreme probability that the disease is not unfrequently transmitted to human beings through eating the flesh or drinking the milk of diseased cows. Professor Gerlach also states that healthy oxen can be infected through the milk of sickly cows, or by taking with their food portions of tuberculous matter from the organs of affected animals.

These investigations proved that tuberculosis could be produced in suitable animals by the introduction, in various ways, into their systems of true tuberculous matter; but some years ago Dr. Burdon Sanderson and Dr. Wilson Fox performed various experiments on rabbits and guinea-pigs, which they believed to prove that tuberculosis could be produced in these animals by inoculating them with any of the products of ordinary inflammatory action, or even by such substances as fatty liver or putrid muscle—nay, even by the production of local injuries, such as a deep wound, or the insertion of a seton. For a time many concurred in these opinions, and viewed the bodies found after the experiments of Villemin, Chauveau, and others as mere inflammatory products, or infarctions, and not true tubercles at all; but the tendency of more recent experiments is to cast doubt on the assertion that any irritating foreign body could induce tuberculosis in these animals, and to confirm the belief that true tuberculous matter alone can produce general tuberculosis, and that the products of inoculation with non-tuberculous matter are not true tubercle, but what Dr. Hippolyte Martin, of Paris, calls false or "pseudo-tubercle." His experiments are so remarkable, and his statements so decided, that we must refer to them; but in doing so we may as well premise that he holds that true tubercle is an infective malady originating in a specific though undetermined virus, and that its propagation arises solely from the conveyance of this virus from body to body. By this one peculiarity, he maintains, is it possible to determine true infective tubercle from the false or non-infective. True tubercle produces general tuberculosis from a local infection, the virus increasing with successive inoculations; whereas non-tuberculous matter after inoculation produces a local tubercle, but inoculation from this secondary tubercle is quite powerless to produce general tuberculosis. He says it is always indispensable to conduct experiments on this matter with the most rigorous regard to antiseptic precautions, lest particles of real tubercle be accidentally injected, and this is the more important because, according to him, it is impossible to distinguish under the microscope, so far as anatomical characters go, between true and false tubercle—the one only distinguishing feature being the infectiveness of true tubercle. In this he is supported by Professor Cohnheim, who, though I am not able to quote his exact words, had previously given his opinion to the effect that under the head of tuberculosis should be ranked all that after its inoculation on suitable animals produces tubercle, while all that fails to do this is not tuberculous; and that the anatomical definition of tubercle is useless and must give place to the etiological.

Dr. Martin conducted two sets of experiments to prove the infectiveness of tubercle. With the greatest antiseptic precautions, he injected into the peritoneal cavity of guinea-pigs irritating substances of vegetable and animal nature, such as pepper, cantharides, fragments of sarcoma, particles from a carcinomatous mamma, particles from the caseation of a sarcomatous tumor, and other non-tubercular matters, with the results that in most instances the animals remained quite healthy, and when killed had no disease of the viscera. In other cases he showed that foreign bodies could set up ordinary inflammatory action, the products of which could not be anatomically distinguished by the microscope from the true tubercle, which always followed inoculation with true tuberculous matter. These secondary tubercles, after inoculation with tuberculous matter, had the distinguishing characteristic of increasing infectiveness from successive inoculations. Hence he concludes tubercle is an infective malady, owing to the presence of some morbific agent, peculiar to it, but undetermined. This agent Koch seems to have discovered in the form of a minute organism, which now goes by the name of the bacillus of tubercle. We may, however, previously enumerate experiments which, while proving that tubercle is infective, also demonstrate some additional ways in which the parasite may find an entrance into the bodies of unaffected persons.

Tappeiner, Bertheau, Weichselbaum of Vienna, and other investigators, caused dogs and some other animals to breathe an atmosphere in which the sputa of consumptive patients and other forms of tuberculous matter were diffused in the form of spray; while they made others respire air through which they diffused atomized liquids impregnated with non-tuberculous substances. The results of these experiments were as follows: In all cases where real tuberculous matter was used, tubercles were found in the lungs, kidneys, and other organs, but especially in the lungs, the abundance of the tubercle being generally proportionate to the length of the experiments and the frequency of the inhalations. In those cases again where non-tuberculous matter was sprayed into the air, either no tubercles were found, or only a very few nodules, and these, perhaps, of doubtful character.

Again, in France, M. Giboux operated on rabbits directly with the air itself expired by consumptive patients, with a view to determine whether it could induce tuberculosis in healthy animals. Into one room he placed a cage containing two healthy rabbits, and into it he passed daily, for some time, twenty or twenty-five liters of air expired by phthisical patients. Into another separated room he placed a second cage also containing two healthy rabbits, and into it he passed daily a similar amount of air expired by consumptives, but previously filtered through tow charged with carbolic acid. The consequences were, that at the end of about three months, the rabbits in the first-named cage became emaciated and showed signs of disease, and at death tubercles were found in all the organs, but especially in the lungs; whereas, in the second pair of rabbits, there seemed to be no injury to health at the end of a like period, and their organs, when the animals were killed, were found free of tubercles.

All these various modes of artificially producing tuberculosis in suitable experiment-animals—some by inoculating tuberculous matter beneath the skin, some by giving it by the stomach, some by injecting it into the veins, others by giving it through inhaling an atmosphere impregnated with tuberculously tainted spray, and others by directly administering the breath of consumptive patients—point to the conclusion that there must be some special infecting virus in real tubercular matter. About five years ago Professor Klebs stated that the contagiousness of tubercle was owing to a microphyte, and his discovery regarding tubercle was proved, by Dr. Schüller, of Greifswalde, to hold good regarding certain affections termed scrofulous; as, for example, scrofulous affections of glands and scrofulous disease of joints, in all of which he said the same microphyte was found.

We will, however, in closing, refer at greater length to the experiments of Koch, of Berlin, as they are the latest, the most striking, and, perhaps, the most decisive. Koch had previously acquired an extended and great reputation by his exhaustive researches into the contagium of splenic fever. His great aim was to discover what the precise character of the contagium was which rendered tubercular disease communicable from one individual to another, and, capable of indefinite reproduction. The result of his experiments was, that in all true tubercles found in cases of general tuberculosis, a special micro-organism was discovered. It may be fittingly asked, Do these micro organisms or parasites occur in any numbers, do they in any degree infest the tissues of a healthy living body, or do they occur only in special states of disease? Koch and others are decidedly of opinion that they do not occur in the tissues of healthy living bodies; and they have also proved that, though different parasites live and flourish under somewhat varying temperatures and attendant circumstances, yet they all agree in this, that, when once introduced into the living body, their life and increase are greatly favored by a low state of the general health. According to Koch, the tubercle bacilli are found within the giant-cells, and they are delicate rod-shaped bodies varying in length from one-quarter to one-half the diameter of a blood-corpuscle. We are further told that these bodies are most numerous in recent and advancing tubercle, and that they become fewer in proportion as the tubercle gets older, and finally disappear on the healing up of the tubercular disease. Dr. Koch also tested the expectoration of many who were suffering from consumption, and invariably found in it multitudes of bacilli, while he could discover none in the sputa of non-consumptive patients. He also found that the bacillus of tubercle required, in inhabitants of the temperate zone, about the warmth of the animal body for its growth and increase; and, in this respect, it differs from the bacillus of other diseases, for we are told that the bacillus anthracis found in cases of splenic fever can live in a temperature much lower than that of the body—outside the body in fact. Having discovered the parasite, the next point which Koch set himself to decide was whether or not it was the real and only cause of infection; or whether some of the matters by which it was surrounded were so. To determine this point it was needful to differentiate the bacilli from the tissues in which they lay; and this he succeeded in effecting by means of a special dye. To make sure that it was the parasite alone that was the medium of infection, and not any surrounding virus, he cultivated the bacilli artificially through many successive generations. With a speck of tuberculous matter from a human lung, he infected different substances, carefully prepared, so as to afford nutriment to the parasite. From these he infected fresh nutritive material, and so on, till many broods of the parasite were obtained. After the bacilli had been several times transferred from one soil to another, the original tubercular matter was at length got rid of, and nothing but the bacilli was left behind. Now, inoculation with these bacilli, isolated from all the original surrounding matter, was followed by reproduction of the parasite, and by the induction of tuberculosis, as certainly as was inoculation with a speck of tuberculous matter containing living bacilli. The same results followed when the bacilli were placed in fluids contained in porous clay vessels — inoculation with the fluid which was sweated through the clay was innocuous, while inoculation with the bacilli was followed by their reproduction, and by tuberculosis.

We have thus traced a belief in the contagiousness of consumption held by a few probably in all ages, springing from observation and practical experience; and we have seen how it is justified by the results of experimental research in our own days, and that at last, within the past few months, the precise infecting parasite has been made a subject of microscopic demonstration.

Now, if Koch's statement, already mentioned, that one-seventh of the human race die of tubercular disease, and that this disease causes fully one-third of the deaths occurring in active middle life, be true, it is impossible to overstate the importance of his discoveries regarding the nature of the bacilli found in tubercle, and in the expectoration of consumptive patients, which he says does not lose its virulence though reduced to a state of perfect dryness. The question now arises, If consumption is an infective disease, can anything be done to destroy its virulence, or to arrest its ravages to a degree hitherto unattained? This much we may safely assert, that the results of all the experiments we have detailed clearly indicate the need of recognizing the parasitic origin of tubercle, of fortifying the body against the inroad, and against all circumstances favorable to the development of the bacilli, as well as of aiming at the destruction of those already pervading the infected organs. With this in view, we must remember the importance of attending carefully to the improvement of the general health of all consumptives, to the avoidance of close confinement in over-heated and over-crowded rooms, to the keeping the patient as much as possible in the open air in suitable

* An address delivered before the North of Scotland Medical Association, July, 1882.—*Lancet.*

weather, to the careful ventilation of sleeping apartments and sitting-rooms, while guarding against preventable draughts, to the separation of the healthy from the sick as far as possible at night, and to warning the healthy against all avoidable inhalation of the breath of consumptive patients, who, in their turn, must be kept from re-breathing their own breath. Serious attention should be bestowed also on the disinfection of the sputa of consumptive persons; and much good may be expected also from the more assiduous use of antiseptic inhalations than has been practiced in the past.

Perhaps in all that has been said we may find a plea for cottage hospitals in open suburban parts, in place of general or large special hospitals for consumptives; and one without doubt for a more careful supervision of the health of cows, whose milk is an article of daily use by the consumptive, and enters so largely into the dietary of all non-consumptives, especially into that of children; as we are told the milk of animals suffering from tubercular disease is capable of transmitting it to previously healthy human beings.

HYPODERMIC USE OF AMYL NITRITE.

DR. J. J. FREDERIC BARNES thus writes in the *British Medical Journal:*

I have administered amyl nitrite hypodermically thirty or more times during the past eighteen months. In all cases a ten per cent. solution in rectified spirit was used. In no case did any untoward inflammatory or suppurative symptoms occur afterward. The action of the drug was immediate in every case, the subjective phenomena being like those experienced when using the ordinary methods of administration. The spirit solution appears to be an excellent preparation for use, as a small quantity kept in an ordinary stoppered bottle for some months retains its full efficiency at the present time. The dose usually administered has been ten minims of the solution, equal to one minim of amyl nitrite. In lumbago, where the patient is seen at the commencement of the attack, and the disease is not of long standing, the drug given in this manner instantly relieves the symptoms; a patient who is unable, previously to its administration, to bend the trunk without the most exquisite pain, five minutes afterward can do so quite readily. In a case of paraffin poisoning, where the patient was in a state of collapse and almost pulseless, one administration (inhalation having been ineffectually tried) brought on an immediate resumption of cardiac function, the man speedily recovering. Its action in this case would, I apprehend, be due to the relief momentarily given to the congested centers by the peripheral hyperæmia induced. In another case, one of duodenal colic, the patient was found rolling on the floor, from the acuteness of the pain; when, on injecting fifteen minims of the spirit solution, the pain disappeared as if by magic, and the patient was at once able to resume his ordinary position. The value of this drug by ordinary methods of administration has already abundantly demonstrated how great a boon the discovery of Dr. Lauder Brunton is in the hands of the profession, notably in cardiac angina; and I feel confident that its utility may be still further enhanced by giving it, as here recommended, hypodermically.

BLEACHING.

PEROXIDE OF HYDROGEN AS A MEANS FOR BLEACHING, AND ITS AVAILABILITY FOR TECHNICAL, MEDICINAL, AND CHIRURGICAL PURPOSES.*

ACCORDING to the researches of Schoenbein ozonized oxygen is said to be the active principle in grass bleaching. Later and extremely exact researches by Emil Schoene have, however, proved, in conformity with the opinions of A. Houzeau and Fr. Goppelsroeder, that ozone is not engendered in the air during the process of bleaching, but, rather, that all the reactions ascribed to the influence of ozone are due to the action of peroxide of hydrogen. Continued quantitative analyses to ascertain the air's titer of peroxide of hydrogen led to the perception that it depends in a great measure on external circumstances, such as the time of year and day, the movements of the air, etc., and Schoene is of opinion that the preponderating influence in its production must be ascribed to the light.

Atmospheric precipitations, particularly hoar-frost, originating under certain conditions, contain considerable quantities of peroxide of hydrogen, namely, 0·04 to 1 milligramme in 1 liter of liquid.

The quantities that came to earth within four months amounted to 62·9 milligrammes per square meter.

Although "grass bleaching"—bleaching with water, light, and air—has been exercised with success for thousands of years, and though there was no lack of time and labor for the perfection of the process, yet there cannot be any misconception as to the fact that it is attended with considerable inconveniences. The result of grass bleaching can never be predicted with absolute certainty, especially within a fixed time. The usual way of bleaching mostly requires a great deal of time, and is attended, besides other drawbacks, with great loss of interest.

It will be sufficient to point to the extremely interesting operation of wax bleaching. There is lying at the wax bleach-fields, near Celle, material to the value of hundreds of thousands of marks, waiting for sunshine and wind. The consideration of these drawbacks will suffice to demonstrate how necessary it is to produce the bleaching medium of nature, the peroxide of hydrogen, in a concentrated form.

Chemistry has at its disposal a long series of combinations which contain oxygen only loosely bound, and which transfer it by their own decomposition to other bodies. These media of oxidation offer a base for the compensation of the oxygen of the air in bleaching, and the following are being technically used: nitric acid, nitrous acid, permanganic acid, chloric acid, chromic acid, and, lastly, the chloric gas in combination with bases in the shape of bleaching salts. However manifold these bleaching media may be, the use of all of them is attended with inconvenience, as they more or less injuriously affect the fiber to be bleached, and for this reason their application is limited and difficult. It is the peroxide of hydrogen alone which does not act in that way; it contains the effective agent operating in grass bleaching in a concentrated form, and is therefore superior to all other bleaching media, and in so far must be marked as the bleaching media of the future.

The peroxide of hydrogen was discovered in 1818 by Thenard, who obtained it by the action of acids on peroxide of barium in the presence of water. Thenard showed that the oxygen of peroxide of barium operated as an oxidizer on the water.

$$xH_2O+BaO_2+H_2SO_4=xH_2O+H_2O_2+BaSO_4.$$

* A lecture delivered by Dr. P. Ebell, at a meeting of the Branch Society of German Engineers, at Hanover. From the *Industrie Blatter*. Reprinted from the *Chemical News*.

A great number of chemists afterward occupied themselves with the peroxide of hydrogen: Pelouze, Duprey, Balard, J. Thomson, E. Schoene. All found the above way for its production the most preferable.

The resulting solutions are always a titer of only 5 per cent. peroxide of hydrogen. The separation of the pure product H_2O_2, is proportionately difficult, on account of its great tendency to decompose. There are two ways of effecting concentration:—(1) Freezing out; (2) Evaporation in a vacuum over sulphuric acid at a temperature of 15° to 20° C. (59° to 68° F.).

The pure peroxide of hydrogen is a sirupy liquid of 1·453 sp. gr., which yields a 475-fold volume of oxygen in its decomposition. Dilute solutions equal solution of chlorine in their effect, and will keep for months in a temperature not exceeding 25° C. (77° F.) if protected from the influence of light. A trifling addition of acid has the effect of diminishing very considerably the tendency to decompose. On the other hand, alkalies and salts producing basic reaction hasten its decomposition.

This tendency of the peroxide of hydrogen to lose its oxygen places it among the media of oxidation. It is not in every case that the real reasons are known for the peroxide of hydrogen quickly surrendering its oxygen. There is a series of bodies which accelerate the evolution of oxygen, without themselves apparently undergoing a change. For instance, all pointed, angular, sharp objects, precipitates, such as alumina and hydrated peroxide of iron, charcoal, as well as several metals when very finely grained, as silver, gold, platina.

In a second series of cases the peroxide of hydrogen acts in the same way as any other medium of oxidation in yielding its oxygen to another body. In course of this process arsenious acid is oxidized to arsenic acid, sulphides are converted into sulphates.

Thirdly, peroxide of hydrogen can apparently exercise a reducing action, losing a portion of its oxygen in decomposing other oxidized bodies. In this manner it reduces the peroxides of lead and of manganese to oxide and protoxide.

In general, it may be said that the peroxide of hydrogen has a deoxidizing action on acids which have an inclination to yield their oxygen (permanganic acid), and an oxidizing action on oxides in alkaline solution which have the opposite tendency.

APPLICATION OF THE PEROXIDE OF HYDROGEN FOR TECHNICAL PURPOSES.

Almost every one who has treated of the subject of peroxide of hydrogen has predicted for it great future importance; the characteristic reactions almost obtrude themselves upon one's observation.

Dumas ("Handbook of Practical Chemistry," Nürnberg, 1830, vol. i., page 119) had used it for cleaning discolored oil paintings and valuable drawings. Starting, as he did, from the consideration that the fading of the paintings arose from the discoloration of the lights put on with white lead through the formation of sulphide of lead, and having regard to the regeneration of the latter by the influence of peroxide of hydrogen into white sulphate of lead, success could not but follow the trials. In spite of this, however, the peroxide was not made use of for a long time; it was only in 1870 that an intelligent perfumer employed it, making it an article of commerce in shape of a 3 per cent. watery solution, as a means for bleaching the hair, and under various names, as, "Eau de fontaine de Jouvence, golden," "Golden hair water," "Auricome." About the same period prominent men drew attention to the faculty of reaction possessed by the peroxide of hydrogen as a recommendation for its use in medicine, as A. v. Schroetter, R. Boettger ("Annals of Chemistry," 1873, page 365), then Geiger ("Handbook of Pharmacy," vol. i. page 213, 4th edition). Hager also gives methods for its production in his "Pharmaceutical Practice."

If in spite of all this peroxide of hydrogen played only a subordinate part, especially in medicine, the reasons are to be found on the one hand in the slighting treatment which was accorded to it by practical chemistry; on the other in its most valuable and specific peculiarities, which in certain directions were antagonistic, and which to superficial observation seem still inimical to its being taken into general use.

In the first place, the production of the peroxide of hydrogen, so far as regards quantities and purity of the article, was, until lately, an unsolved problem.

What practical chemistry could offer were only solutions charged with impurities in the shape of various salts and acids, and of the most uncertain and varying composition. For this reason alone, uniform thorough success in any direction could not be attained. But besides that, the price could not be but enormous in consequence of the disability to fully exhaust the materials used in its manufacture, and an entire want of demand for the article. These drawbacks are now overcome, and peroxide of hydrogen can be had in watery solution with a titer of 3 per cent. by weight, or of 10 volumes, in a uniform, chemically pure state, at low prices and in large quantities.

The doubts with regard to durability and to transport to distant parts may be considered as solved.

The watery solution corresponds in its conditions to solution of chlorine; when light is excluded, and temperature does not exceed 25° C. (77° F.), it loses only a trifling amount of its entire titer of peroxide of hydrogen, and, therefore, the "peroxide of hydrogen question" must be considered answered with regard to its first part, comprising its chemical production and its capacity of undergoing unharmed the difficulties of transport.

PEROXIDE OF HYDROGEN AS BLEACHING MATERIAL FOR PRODUCTS OF ANIMAL ORIGIN.

All products which are to be subjected to a bleaching process by peroxide of hydrogen, must be submitted to a preparatory treatment, the purpose of which is to render them capable in every part of being moistened by a watery solution of the peroxide of hydrogen. Every particle of fat, sweat, and impurity adhering to the objects to be bleached must be taken away.

Besides bathing in a solution of good soap, solutions of 3 to 5 per cent. of carbonate of ammonia have in the first place shown themselves of value; in various cases new means of solution, such as sulphide of carbon, benzene, ether, etc., have been found available.

With regard to the process of bleaching itself, two different principles can be brought into operation.

The watery solution of 10-volume peroxide of hydrogen is neutralized as far as possible by some drops of liquid ammonia and used directly as a bleaching bath.

For a continued process of bleaching it is advisable to use a series of baths, through all of which the object to be bleached passes systematically, commencing with the weakest. Light must be excluded, and temperature not be allowed to exceed 25° C. (77° F.).

The second method is based on the same principle, but carried out in a different way.

The objects preliminarily prepared as above stated are steeped in the solution of peroxide of hydrogen. After being fully impregnated with the liquor, they are taken out and subjected to a process of drying in a current of air, which must not exceed a temperature of 20° C. (68° F.).

The process of bleaching progresses energetically during the evaporation of the water, and the concentration of the solution of peroxide of hydrogen occasioned thereby.

It is a matter of calculation, or depends upon other circumstances, whether the one or the other proceeding is to be carried through.

BLEACHING OF HAIR WITH 3 PER CENT. SOLUTION OF PEROXIDE OF HYDROGEN.

The hair is digested for twelve hours in a solution of 3 parts carbonate of ammonia in 1,000 parts of water, at a temperature of 30° C. (86° F.), rinsed, then washed with soap, and all the fatty matter removed with the help of a fresh solution of carbonate of ammonia. Benzene can also be recommended. Prepared in this way, it is immersed in a bath of peroxide of hydrogen, fully neutralized with liquid ammonia.

It either remains in the bath until sufficiently bleached, or is dried in a room at ordinary temperature, and the immersion repeated.

The baths must only be considered fully exhausted when some drops of permanganate of potash produce in the liquor a permanent red coloration.

It has not been found feasible to bleach black hair so that it becomes perfectly white, its color only disappearing so far as to arrive at a light golden fair hue. Even a jet-black Chinese tail does not resist.

The bleaching of hair, even on living persons, does not present any difficulties. After the desired degree of bleaching has been arrived at, an after treatment by washing with water, followed by a wash with alcohol, takes place; hot liquids or drying in drying chambers, are excluded.

BLEACHING OF FEATHERS, ESPECIALLY OSTRICH FEATHERS.

As a means of bleaching feathers, the peroxide of hydrogen is far superior to all other substances proposed for the same purpose, and has proved itself of value in every way, especially for ostrich feathers.

Its superiority rests especially on the oxidation and thorough removal of coloring matter, without the slightest detriment to the structure of the feather itself.

By way of preparation, the feathers are placed into a bath of carbonate of ammonium, containing 1 to 2 parts of salt in 100 parts of water, where they are left for twelve hours at a temperature of 20° C. (68° F.), being gently moved about in the bath the while.

After this they are being steeped and moved about in a lukewarm bath of Marseilles soap, and at last well rinsed with water exempt from lime. Boiling or hot liquids must be excluded.

Treatment with pure benzene and ether has also shown very good results.

For feathers it is only admissible to bleach in baths, which must be made neutral, and not be prepared and kept in metal or wood vessels. Earthenware or stoneware vessels are the best adapted for the purpose.

In cases where the feathers are for a long time exposed to the influence of slightly acidulated liquid, there occur, as with all other organic matter, appearance of wasting away in the liquid; they begin to show signs of decay, and lose their beauty to a great degree.

The bleaching finished, the feathers are slowly dried in a low temperature and in moving air, while being repeatedly beaten. At higher temperature the formation of gluey matter easily takes place, in consequence of which the finest fibrals stick together; beating acts as preventive to that drawback.

It was formerly proposed to dust the feathers while still in a damp state with hair powder, and then only to dry them. The powder acts on the feathers in a similar way as do tanning materials in tanning; like these, it prevents the tendency to flaw.

Very favorable results may be attained by steeping the bleached and still wet feathers in alcohol; this makes the gluey insoluble formations settle down, and the liquid evaporating at very low temperature, it leaves the feathers of a woolly and beautiful appearance. By steeping the feathers in benzene, and allowing it to evaporate, the same end is gained with even better results.

The further treatment of the feathers, as scraping, trimming, and curling, can only be mentioned here in passing.

The success of the bleaching of feathers in the above manner is thorough in comparison with other proceedings. Even entirely black spots are bleached after continued action of the bath.

BLEACHING OF SILK WITH PEROXIDE OF HYDROGEN.

For bleaching silk, a whole series of strong oxidizers, as permanganic acid, chromic acid, nitric acid, have been proposed, and besides them sulphurous acid has been used to advantage. As is the case with beeswax, the coloring matters of raw silk are capable of resisting bleaching materials in different degrees; some sorts of silk are easily susceptible to their influence, while others resist it strongly.

Among the latter is the product of the wild silkworm, the so-called Tussah silk, a fine and durable thread of strongly pronounced brown color.

According to our trials, peroxide of hydrogen is the best means of bleaching this silk, the objectionable brown color being reduced by its action to a but little distinguishable, pleasing yellow. After the boiling of the gum by subjecting the raw silk to a treatment with soap baths of various strengths, and final boiling in concentrated solutions of soap, it is recommended to treat it with carbonate of ammonia.

After that the scoured silk must be subjected to the action of peroxide of hydrogen, in the same way as mentioned under the head of "bleaching of hair."

Alcohol, eventually mixed with a little glycerin, has in this case also shown itself of value for an after treatment.

BLEACHING OF IVORY AND BONE.

Records as to the bleaching of bony substances and ivory are very scarce.

Almost universally the process of bleaching in sunlight by means of air and water, which is very trying to the bone, is had recourse to; for ivory, chloride of lime has been proposed.

The purpose of the preparation of the bone is, as in the case of all the other substances heretofore mentioned, the

removal of fatty matter. While formerly they were treated with steam under pressure, and the fat skimmed off, there have lately been patents taken out for using solvents, such as sulphide of carbon, ether, benzene, and it is said that their use offers advantages as compared with the former way of proceeding, not only with regard to quality and quantity of fatty matter, but also in consequence of the loss of gelatinous substances being only trifling.

Lyes of carbonates of alkalies must be more or less excluded for the above purpose, but weak solutions of carbonate of ammonia may be used.

The bones, freed from fatty matter, are immersed—preferably while in a primary state of manufacture—in an almost neutral solution of peroxide of hydrogen, and left in this bath as long as may be requisite. The process of bleaching takes place smoothly and safely; even spots of blood in the pores acquire a perfectly white appearance.

Ivory is treated in exactly the same way as bones; fans, handles of walking sticks, and knife handles, bleached by peroxide of hydrogen are already being used very extensively.

APPLICATION OF PEROXIDE OF HYDROGEN FOR MEDICINAL PURPOSES.

The peroxide of hydrogen has not hitherto played a conspicuous part in therapeutics. The reason for that may be, that formerly pure and durable solutions were not to be had at a reasonable figure. Price, however, is no longer an impediment to its use, and the tendency of the peroxide of hydrogen, as at present obtainable, to decompose, can be considerably restricted; possibly peroxide of hydrogen turned into simple water, may formerly have led to wrong conclusions. Peroxide of hydrogen, if preserved in the dark, and in a temperature not exceeding 25° C. (77° F.), keeps unaltered for months. For ascertaining its titer of active oxygen, a normal solution of permanganate of potash is requisite; it would be advisable to fix a minimum titer of active oxygen. It is to be supposed that peroxide of hydrogen, like chloride, bromide, and permanganate of potash, is poison to the smallest organisms (bacteria); exact comparative experiments with a view to ascertain this are much to be desired, considering the importance of the matter. Experiments with yeast, instituted by the lecturer, had very favorable results, and proved that the germs of the yeast are entirely killed by peroxide of hydrogen, even when greatly diluted.

As regards the fitness of peroxide of hydrogen for treating wounds, caused by syphilitic, scrofulous, and tuberculous ulcers, favorable experience has been gleaned by a physician at Hanover. It is probable that peroxide of hydrogen will do good service in the shape of spray in making operations and ligatures; this would be important, considering the effect which carbolic acid spray often has on operators and patients.

The great advantages possessed by peroxide of hydrogen, as compared with other media of disinfection, are:

(1) Complete absence of smell.

(2) Yielding oxygen without leaving any other residiuum but pure water.

(3) Absence of injurious influence on the organism.

The workmen occupied in making the peroxide of hydrogen get exceedingly delicate hands, and wounds heal visibly under its influence.

There further seems room for employing the peroxide of hydrogen as a means of disinfecting sick chambers and generally for purifying the air. It would be advisable to spread by means of a rafraichisseur spray of diluted peroxide of hydrogen by way of trial.

Attention must also be drawn to the use of peroxide of hydrogen in dentistry, as has in the first place been done by C. Sauer (*Quarterly Review of Dentistry*, 1879, No. iv.). Sauer made use of the peroxide of hydrogen with success in bleaching discolored and carious teeth. In cases where the teeth are covered with colored matter (*Lichen dentalis*, etc.), he employs peroxide of hydrogen in conjunction with finely levigated pumice stone, as a means of cleaning in place of water. Teeth, the native channels of which were filled with colored matter, became somewhat paler after several applications. A suitable liquid for cleaning teeth and mouth is prepared by mixing 1 part of 3 per cent. peroxide of hydrogen with 10 parts of water. In case of carious teeth, the peroxide of hydrogen on wadding was locally used with advantage.

GAS AND SUGAR APPARATUS AT THE SAINT QUENTIN EXHIBITION.

WE illustrate herewith some apparatus shown at the Industrial Exhibition at Saint Quentin, France, by Mr. Daix of that place.

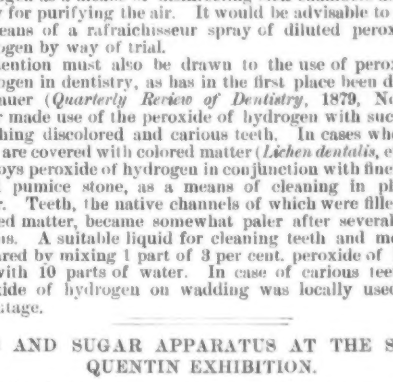


FIG. 1.—IMPROVED GAS APPARATUS.

Figs. 1 and 2 represent apparatus for the manufacture of gas, and are of some interest as regards the arrangement of the retorts.

In ordinary gas apparatus the material to be distilled is thrown into retorts made of either refractory clay or iron. In large works, recourse is generally had to the first-named material; but in smaller ones, and especially in manufacturing establishments that make their own gas, iron is generally the material employed.

Retorts made of refractory clay give an extremely gentle and regular heat, but possess the drawback that they crack on cooling. This is why they are employed only in large establishments, whose furnaces are in continuous operation.

In small towns, and in manufactories generally in which gas is produced only in winter, and in which the furnaces are stopped in summer, the expense of replacing clay retorts would prove much too great; and this is why they have been replaced by cast iron, which does not crack under the alternate influence of heat and cold, but which nevertheless present the grave inconvenience that they burn quite rapidly and become distorted through the action of the heat.

In the apparatus exhibited by Mr. Daix, the retorts that

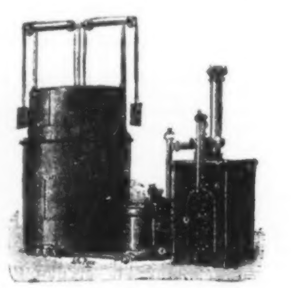


FIG. 2.—DAIX'S PORTABLE GAS APPARATUS.

receive the material to be distilled, although made of cast iron, are surrounded by a jacket of fire-clay formed of separate parts, so as to be able to expand easily, and designed to receive the direct action of the fire, and prevent the retort from burning, by making the action of the heat regular.

We have then, with this simple system, all the advantages of refractory clay retorts without their inherent disadvantages.

Fig. 1 shows a furnace of three retorts, which is the type adopted in small towns and in factories having a need of 300 or 400 burners.

Mr. Daix also constructs furnaces of five retorts, and groups of two and four furnaces, according to the amount of light to be furnished.

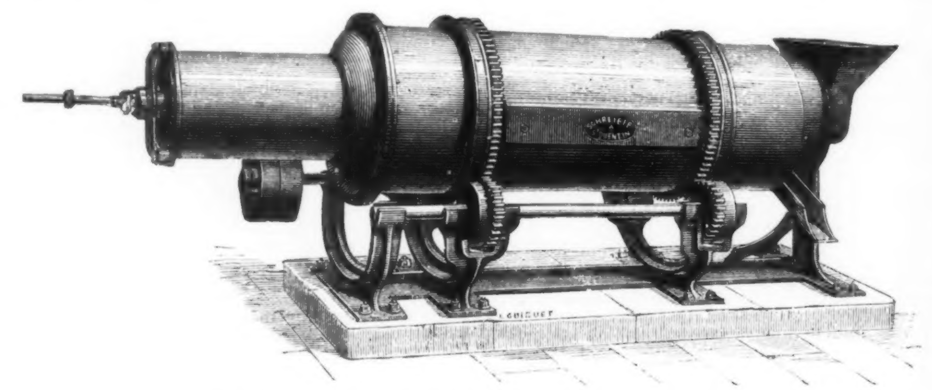


FIG. 4.—APPARATUS FOR WASHING ANIMAL BLACK.

Fig. 2, which represents a portable apparatus capable of supplying 30 to 35 burners, consists of a furnace properly so-called, constructed of special fire-bricks that are introduced into a cast-iron jacket having plate iron squares. It is also provided with cast-iron purifying apparatus, and a gasometer and well both of boiler plate.

The apparatus is extremely simple, easily transportable, and very readily set in operation. It produces gas with coal, petroleum, cork, volatile oils, etc., and the gas produced is of great purity, and is very luminous and white.

The cost of the gas thus obtained, not counting interest on the investment, is 0·08 to 0·10 of a franc per cubic meter, counting the coal at the rate of 2·25 francs per kilogramme. The price of lighting each burner per hour is about 0·01 of a franc.

Mr. Daix also exhibited many apparatus designed for the sugar manufacturing industry, and of these the following are the more important:

First, a furnace for revivifying animal black, on the Schreiber system, and which is shown in Fig. 3. What distinguishes this furnace from all others is the arrangement of its retorts, which are vertical and corrugated. Owing to such a disposition, the black passes into all positions possible, from the top to the bottom of the furnace. There is by this means avoided that defect inherent to most other systems, in which there is obtained black both burned and incompletely revivified.

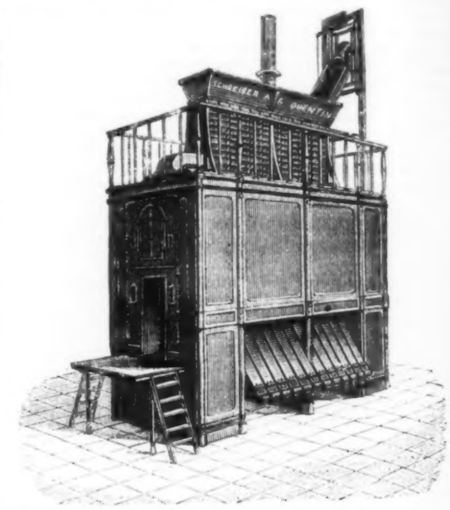


FIG. 3.—FURNACE FOR REVIVIFYING ANIMAL BLACK.

One of the most recent modifications that has been made in the apparatus consists in the addition of an automatic drier.

Figs. 4 and 5 represent a rotating washer for animal black. Nearly all apparatus of this kind have the defect that they produce a large amount of black in powder or in rounded grains, whose action is not so good as that in which the grains are angular. In this apparatus, the black, along with a certain quantity of water, is raised to a certain definite height, and the whole is afterward emptied into the same bath.

The washer consists of a hollow horizontal cylinder, L, two meters in length by 0·7 of a meter in diameter, surrounded by two smooth bands, F, designed to revolve on four friction rollers, F′, which are supported by bearings, O, that form part of the bed-plate, I.

This cylinder is revolved through the intermedium of pinions making part of the rollers, F′, and gearing with two crown wheels, E, that are fixed upon the cylinder at the side of the bands. Two shafts, upon which are keyed the pinions, receive their motion through the intermedium of the pulley, A. In the interior of the cylinder, and forming part of it, are two paddles, L′, which have a curved surface, and which divide the circumference into two equal parts. These surfaces are slightly inclined in the direction toward which the black makes its exit.

To wash the black it is only necessary to let in the latter

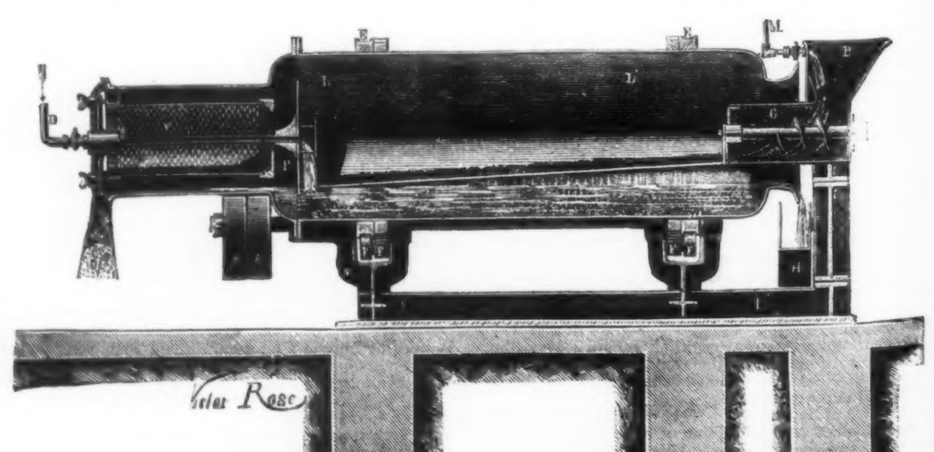


FIG. 5.—VERTICAL SECTION OF WASHER.

at B and the water at D. The black is introduced in a continuous manner by means of an Archimedes screw, G, and a jet of water coming through the pipe, M.

On revolving, the paddles of the cylinder carry the black from the bottom of the water up to a certain height, when the curved portion, L', reverses and allows the black to fall into the water contained in the cylinder.

As a consequence of the inclination of the curved surfaces, the grains of black are gradually displaced until they reach the opposite extremity of the cylinder, from whence they are naturally thrown outside; a filter, C, having the form of a bolter, and consisting of an envelope of perforated sheet iron, C', frees the black of the greater portion of the water that it carries along with it.

THE DETECTION OF CHLORIDE OF LIME IN WATER.

By A. ANTHONY NESBIT, F.C.S.

THE increasing disputes between owners of paper mills and those preserving fish have rendered it advisable that chemists should have a very delicate test for bleaching powder, which is the most deleterious pollution of streams by paper mills. I have consequently conducted a long series of experiments which have resulted in the following method, the delicacy of which is such that it enables us to detect from the two-hundredth to the four hundredth part of that quantity of chloride of lime which is injurious to Prussian carp (*Cyprinus gibelio*).

The test used is a starch paste made in the following manner: 100 grs. of iodide of potassium are dissolved in 16 oz. of boiling water, and 100 grs. of starch mixed with 1 oz. of cold water are added gradually, and the whole boiled vigorously for 30 minutes (the long boiling being absolutely necessary for the production of the sensitiveness of the test).

This solution should be used as soon as possible after its preparation, as it rapidly decreases in delicacy, and the extraordinary fact must never be lost sight of that an excess of this test entirely destroys the reaction.

I test a water in the following manner, viz., two No. 5 beakers of the same shape are filled with the water under examination from the brook side and placed on a sheet of white paper, and 5 c. c. of the above solution are run from the burette into one of them; if no blue or violet color occurs at once, the water is thrown away, the beaker is refilled and 1 c. c. run in; if again no reaction, the beaker is again refilled and half a c. c. added, the beaker recemptied, and so on, till only the tenth of a c. c. is used in the beaker—it being found that the smaller the quantity of chloride of lime present the smaller the quantity of test required to exhibit it, and when we are dealing with small quantities of the chloride it has to be searched for with varying amounts of the test or it may escape notice.

By judiciously applying the above method I can detect the one two-hundredth of a grain of commercial bleaching powder in one gallon of water, or about one eight-hundredth of a grain of "available chlorine" in a gallon.

Now, from numerous experiments which I have conducted I find that it requires from one to two grains of commercial chloride of lime to inconvenience Prussian carp, consequently we can readily detect in so-called polluted water the one two-hundredth to the one four-hundredth part of the quantity which is injurious to these fish; and hardy as the Prussian carp are, I think it must be conceded that it would be unreasonable to consider that the common trout is two hundred times as delicate.

In future disputes, therefore, between the owners of paper mills and fish preservers there will be no difficulty in deciding whether or no the manufacturer habitually discharges an injurious quantity of chloride of lime into the stream.

I find, however, that chloride of lime in small quantities is rapidly reduced by the action of the organic matter in the water, which fact must not be lost sight of, and every hour's delay in testing makes it more difficult to indicate pollution.—*Chem. News.*

VOLUMETRIC DETERMINATION OF LEAD.

By M. BUISSON.

THE author's method is based on the precipitation of lead by potassium bichromate in excess; the excess of the bichromate employed is found by decomposing it in the cold by potassium iodide in presence of sulphuric acid. The reaction is almost instantaneous at common temperatures, and is complete in two or three minutes. The iodine set at liberty is determined with sodium hyposulphite as indicator; either the disappearance of the blue tint of the iodide of starch or the decoloration of iodine in carbon disulphide may be made use of. The author prefers the latter, as being much the more sensitive, for the liquid being always tinged greenish by the salt of chrome produced, the sensibility of the reaction of starch is much lessened. The standard solution of bichromate is prepared by dissolving in distilled water 14·248 grms. pure fused potassium bichromate, and making the solution up to 1 liter: 5 c. c. precipitate exactly 0·1 grm. lead. The relation between the standard liquids of bichromate and hyposulphite is thus determined. With a pipette, 25 c. c. of the bichromate liquid are taken and diluted with water to 250 c. c. Of this new solution 50 c.c. are taken and put into a stoppered bottle capable of holding 250 to 300 c. c. The liquid is then acidulated with sulphuric acid (free from chlorine and nitrous vapors), and about 0·5 grm. potassium iodide is added. When the decomposition is effected about 5 c. c. carbon disulphide or chloroform is added. The solution of hyposulphite is then added by means of a burette graduated in one tenths of a c. c., until the rose color of the carbon disulphide disappears: the quantity of hyposulphite added corresponds to 5 c. c. of bichromate or 0·1 grm. of lead. The solution of hyposulphite is sufficiently strong if from 35 to 40 c. c. are required to decolorize the iodine set at liberty by 5 c. c. of bichromate. The sulphuric acid should not be added in too large excess, as it might decompose the hyposulphite before the latter can act upon the iodine. In order to verify the standard of the bichromate, 0·3 grm. of pure lead is dissolved in pure, hot nitric acid, for which purpose there are required about 20 drops of acid in 5 c. c. of water. When the lead is dissolved the liquid is heated to a boil to expel nitrous vapors, and the excess of acid is saturated with potassa until a permanent precipitate is obtained, which is then redissolved by a few drops of acetic acid. The solution of lead is poured into a graduated flask of 250 c. c. with 25 c. c. of the bichromate solution, and distilled water enough to make up the 250 c. c. After standing for fifteen minutes, the liquid is poured upon a dry filter, and the operation is completed in the same manner as if the bichromate alone were present, as described above. The difference between the quantities of hyposulphite employed for decomposing the bichromate before and after partial precipitation by lead represents the bichromate in c. c. of hyposulphite, and consequently the lead which has been precipitated. For the assay of lead ores, the sample is ground in an agate mortar, and from 0·5 to 1 grm., or more, is weighed out according to its richness. The weighed portion is dissolved in a few c. c. of boiling hydrochloric acid, and a little potassium chlorate is then added to peroxidize the iron, and the whole is boiled for a few minutes to expel chlorine. The liquid is then saturated with an excess of caustic potassa, and the precipitate is redissolved in a few drops of acetic acid. It is then boiled again to precipitate the iron, and aid the solution of the lead sulphate if any has been produced. The solution is filtered, and the precipitate is washed in boiling water. To the cold liquid there are added 25 c. c. of bichromate and water, so as to make up 250 c. c. After settling for fifteen minutes, the liquid is poured upon a dry filter, and 50 c. c. of the filtrate are taken and treated as described above.

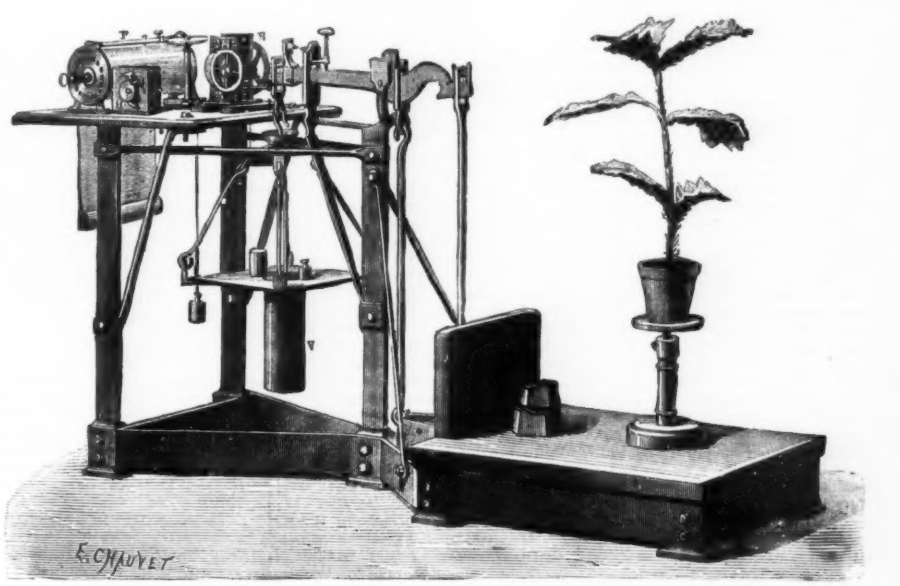
CONTINUOUS EQUILIBRIUM WEIGHING APPARATUS.

THE apparatus shown in the annexed figure has been constructed according to data furnished by M. Hervé Mangon, former director of the Conservatoire des Arts et Metiers, and is designed to furnish physicists, physiologists, and agriculturists with a means of experimenting on everything connected with modifications in weight.

It is a constant equilibrium scales, which registers continuously the variations in weight of any body whatever, animate or inanimate.

The apparatus is constructed as follows: There is employed an ordinary commercial scales, on the smaller platform of which there is a vessel, V, three-quarters full of water. If we insert a cylinder into this vessel we shall add proportionally to the weight of the platform that supports it. The operation of the apparatus is based upon this latter principle.

The extremity of the scale-beam is provided with a small hooked needle that acts upon a special mechanism, R, actuated by a clockwork movement. When the weight with which the larger platform is loaded increases or diminishes, the beam rises or descends, and its hooked needle acts upon the mechanism, R, and changes the direction of its rotation.



CONTINUOUS EQUILIBRIUM WEIGHING APPARATUS.

A small channeled pulley, dependent on this motion, carries a cord to whose lower extremity is attached the cylinder that dips into the vessel, V. So that if the object placed on the large platform increases in weight, the mechanism, R, will at once cause the pulley to revolve from left to right; and the cylinder then entering the vessel, V, will increase the load of the small platform and re-establish the equilibrium, thus keeping the needle of the beam always at zero.

If the weight diminishes on the large platform, the opposite effect will take place; the cylinder will rise and lighten the small platform, and equilibrium will be established again as before.

The evaporation of water from the vessel, V, cannot destroy the equilibrium, for, as soon as the weight diminishes on the small platform, the cylinder descends and acts as a compensator.

This apparatus is provided with a cylinder, P, which carries rolled around it a band of paper upon which a style traces the curves of the variations in weight. This style, which is mounted on a rod parallel with the axis of the cylinder, is moved by a thread connected to the pulley of the mechanism R. When the pulley rolls up the thread it causes the style to move in one direction; and as soon as the clockwork movement, R, changes the direction of its rotation, under the action of the hooked needle of the beam, the pulley unwinds the thread, and the style is carried in the opposite direction by means of a counterpoise.

The cylinder, P, is set in motion by a clock at any rate of speed desirable.

From what precedes we may deduce two principles as regards this apparatus:

1. The motions of the plunging cylinder are proportional to the changes in weight.

2. The motions of the style, for a same change in weight, are proportional to the diameter of the plunging cylinder, that is to say, cylinders of small diameter will give curves that are more pronounced than those of large diameter.

The large platform, although able to carry as much as 300 kilogrammes, registers decigrammes; a lighted candle writes, of itself, its combustion; a plant inscribes the variations in weight due to its growth, etc. Such delicacy as this is due to the constant state of oscillations which actuates the beam and moves it by extremely short distances.

MEAT TRANSPORT FROM NEW ZEALAND.

WHAT may be regarded as a "new departure" of a very important character has just been made in the importation of refrigerated fresh meat from the antipodean colony of New Zealand. In the particular case of which we are about to give some details, there is involved a great deal of scientific and practical interest, for the consignment of the meat itself is the first cargo that has yet been brought to this country from New Zealand, and not only so, but it is also the first cargo that has been carried across the ocean, through the tropics, and half-way round the globe, in a sailing ship. The vessel in question is the iron ship Dunedin, 1,250 tons register, built by Robert Duncan & Co., Port Glasgow, in the year 1874, and owned by the Albion Shipping Company, of Glasgow, of which Mr. Peter Denny, of Dumbarton, is the chairman.

The enterprise in which that vessel has just been engaged, and is likely to be further engaged, has arisen in some measure out of the disastrous failure of the City of Glasgow Bank several years ago, one of the assets of which is a great extent of land held in the name of the New Zealand and Australian Land Company of Edinburgh and Glasgow. Being desirous of turning that property to the best account, the directors of the Land Company, about a twelvemonth ago, consulted Mr. J. J. Coleman, of the Bell-Coleman Mechanical Refrigeration Company, of Glasgow, in reference to the possibility of bringing home a cargo of fresh meat from New Zealand by sailing ship, on the supposition that it would be necessary to have a refrigerating machine on shore for freezing the meat and one on board the vessel for maintaining it in the frozen condition during the voyage. As a result, negotiations were opened up between the Land Company and the Albion Shipping Company, whose ships, it should be mentioned, are largely occupied in the importation of wool from the antipodean colonies into the Thames, it being the aim of the Land Company to have one of those ships adapted for the meat-carrying trade as an experiment. Considering the fact that in New Zealand alone there are somewhere about 13,000,000 or 14,000,000 sheep, such an experiment was certainly one of far-reaching importance, alike to the colonists and to the people at home, who are dependent on other countries for at least 33 per cent. of the meat which they consume.

It was feared by the directors of the Land Company that if the experiment required that two refrigerating machines should be employed, one at the port of shipping and the other on board the vessel, the cost would be too great to admit of the enterprise being made a successful one from a pecuniary point of view. Mr. Coleman found, however, that he was able eventually to suggest to them that under certain conditions one machine might be made that would be sufficient to overtake all the refrigerating work. The suggestion was that all previous practice in meat refrigeration should in a measure be set aside, and that a very powerful machine should be fitted in to the vessel, one capable of producing refrigerated dry air at the rate of 70,000 cubic feet per hour. He argued thus: As the freezing of fresh meat involves the abstraction of about 145 deg. of latent heat in addition to the 40 deg. required to reduce the meat from a temperature of, say, 72 deg. (that of the meat cooled naturally) to 32 deg., a machine of the power just mentioned would, theoretically, be required for freezing meat at the rate of 20 tons per day. It was assumed that, in actual practice, about 10 tons of dead meat per day could easily be obtained by the facilities on shore for killing, dressing, etc.; and in order to avoid having to go to the expense of purchasing and fitting up two machines, the Albion Shipping Company agreed to allow their vessel to remain in port during the time necessary for the meat to be put on board in small daily installments of 10 tons or so, assuming, of course, that the cargo of wool would be stowed away before the meat could all be got on board in a satisfactory manner. The owners of the Dunedin went to the expense of about £5,000 for the refrigerating machine, together with the necessary boilers, etc., and for the internal reconstruction of the ship so as to adapt her to the altered circumstances of the case. Messrs. D. & W. Henderson & Co., of the Finnieston Steamship Works, Glasgow, made the machine, their experience in constructing such plant dating back to the very commencement of the Bell-Coleman system of refrigerating dead meat. If we mistake not, this machine, at the time it was put on board the Dunedin, was the largest meat refrigerator that had then been made. The internal reconstruction just referred to included the adaptation of a large portion of the hold of the ship as well as a considerable extent of the 'tween decks space; and this is, we believe, the

first practical deviation from the usual plan of having the cold chamber in the 'tween decks only in vessels carrying dead meat.

In carrying out this interesting and important experiment, the principle adopted was in the first place to freeze each day's supply of carcasses while hanging in the 'tween decks space, and then, after each of the carcasses had been sewn in a coarse calico bag, to take them into the hold amidships, where they were packed, "head and tail," as closely as they could be stowed. The depth of the hold was nearly 18 feet. Eventually the cold chamber in the hold was completely filled with frozen carcasses in the way mentioned, and then the 'tween decks space was packed in a similar manner, until at last nearly 5,000 sheep and some 400 lambs were aboard in the refrigerating chambers.

The principle observed in providing for the distribution of the cold air was to bring it first into contact with the carcasses that were already frozen, and then to bring under its influence those requiring to be frozen in the 'tween decks chamber. In adopting this mode of distributing the cold dry air, the object aimed at was not to maintain a uniform temperature throughout the meat chambers, but rather to make it absolutely certain that the air passing through the mass of meat in the 'tween decks was always at a temperature somewhat under 32 deg. Fahr., under which circumstances the lower hold, which first received the air from the refrigerating apparatus, must necessarily have been very much colder. That was most desirable, so as to insure the perfect rigidity of the carcasses; for had the meat not been thoroughly frozen before being packed away in the lower chamber and still kept in that condition, the mere dead-weight of the superincumbent portion would have crushed the carcasses forming the lower layers into a shapeless mass. As it was, however, the carcasses of mutton and lamb forming this experimental shipment arrived in the Thames, after a passage of ninety-eight days, in their naturally rounded condition, and as faultless in shape as those that may be seen hanging in any butcher's shop. In the case of shipments of fresh mutton from Australia it has not unfrequently happened that the carcasses have arrived quite misshapened, evidently in consequence of the ineffectual freezing power applied to the carcasses before stowing them away even in the comparatively shallow space of the 'tween decks.

This shipment by the Dunedin is highly important from the fact that it has afforded accurate scientific data in regard to the refrigerating power really required, as the operations both of freezing and carrying have been entirely under one control. Hitherto the shipments of fresh meat from Australia have only been partially successful, owing in some measure, doubtless, to the fact that the carcasses have not been frozen on shore by the same sort of machine as that used in the ship carrying the meat; and there is good reason to suppose that the freezing power employed on shore has not been at all adequate for the work to be done.

The Bell-Coleman machine on board the Dunedin occupies, together with the ship's linings and the upper and lower meat chambers, about 600 tons gross of carrying capacity, calculated at the rate of 40 cubic feet per ton; and the total internal capacity of the meat chambers was about 400 tons, calculated at the same rate. In that amount of space there were packed about 175 tons of meat; but as the refrigerating machine was only worked to about half its power during the voyage, it is proposed to increase the internal capacity of the meat chambers about 50 per cent. for the next voyage. The machine is provided with a surface condenser, and it has a pair of compressing cylinders each of 21 in. diameter, with a piston stroke of 24 in. in length. Steam was generated by a pair of vertical and multitubular boilers, each having about 400 square feet of heating surface. The average number of revolutions was 60 per minute, and the average air pressure was 34 lb. per square inch, while the daily average number of hours that the steaming was maintained during the voyage was 15, and the consumption an average of 3 lb. per indicated horse power. While the refrigerating air was delivered from the apparatus at a temperature of about 80 deg. below zero, the average temperature of the lower hold was 5 deg. Fahr., and that of the upper hold, or 'tween deck space, was about 22 deg.—*Engineering.*

PROPER MOTIONS OF THE STARS.*

By PROFESSOR R. GRANT, M.A., LL.D., F.R.S.

THE spectacle presented by the stellar heavens as viewed by ordinary observers is characterized by two remarkable features: the absence of uniformity in the brightness, and the absence of uniformity in the distribution, of the stars. Certain of the stars soon came to be recognizable by their superior luster, and certain groups of stars became familiarly known as so many landmarks in the stellar firmament. The way was thus prepared for an important discovery. It was ascertained respecting a limited number of the stars that their places in the heavens relatively to the general multitude of the stars were continually changing. They consequently received the appellation of planets, or wandering stars, while, on the other hand, the stars in general, in consequence of their always maintaining the same relative position, were denominated *fixed* stars. Ptolemy, in his great work upon the astronomy of the ancients, places the earth in the center of the universe, and assumes the sun, moon, and planets to be revolving in orbits around it, while beyond all was the sphere of the fixed stars, which revolved with a uniform motion around the earth, effecting a complete revolution once in 24 hours. No opinion is expressed respecting the nature of the stars, nor is any allusion made to the possibility of the stars being endued with a proper motion.

When Copernicus propounded the true system of the universe, he made the earth a planet revolving like the other planets round the sun, and he explained the phenomenon of the diurnal revolution of the starry sphere by the revolution of the earth upon a fixed axis in the opposite direction. No opinion was expressed by him respecting the physical nature of the celestial bodies, or their having any probable community with the earth in this respect. Indeed, it could hardly be said that any new light was thrown upon the physics of astronomy by the theory of Copernicus. As a mathematical exposition of the movements of the celestial bodies it was eminently successful. Indeed, it wanted only the discoveries of Kepler respecting the elliptical movements of the planets to make it perfect in this respect. But it must be acknowledged that in the system propounded by Copernicus the earth was regarded as the body of paramount importance in the universe.

It was the invention of the telescope, and its application to the purposes of astronomical observation, which first revealed to the human mind the marvelous extent of the physical universe, and suggested the idea that the earth might be a mere atom in comparison with the vastness of the material system beyond. When it was discovered that the planets are round dark bodies like the earth, shining only by the reflected light of the sun, and that they presented apparent diameters of sensible magnitude when viewed through the telescope, no doubt was henceforward entertained that the planets are bodies comparable with the earth in magnitude, and that the earth is merely one of a family of similar bodies which revolve in orbits of different magnitudes around the sun. It is worthy of remark that Galileo, to whom is due the telescopic discoveries which first disclosed the vast extent of the material universe, has nowhere expressed any opinion respecting the nature of the stars. His mind was probably too much occupied with the more immediate consequences of his discoveries to indulge in speculations leading to more remote conclusions; and a similar remark is generally applicable to his successors in the field of telescopic exploration who flourished during the seventeenth century. It was reserved for Huyghens to propound the doctrine that the stars are suns. This he did in a work on Cosmical Astronomy, which was published in 1699, shortly after his death. Henceforward the stars have been regarded by astronomers as self-luminous bodies, comparable in magnitude and splendor with the sun.

While more correct ideas were being formed respecting the nature of the stars, the method for ascertaining the exact position of an object in the celestial sphere underwent at the same time a complete revolution. The telescope in its original form was not suited for aiding the observer in fixing the precise position of a star in the heavens, but the subsequent form of the telescope, consisting of a combination of two convex lenses, suggested the admirable invention of telescopic sights, which may be said to constitute the foundation of all exact astronomy. The places of the stars were now determined with a vastly greater degree of precision, and the way was thus prepared for the consideration of the important question, whether the epithet *fixed* is strictly applicable to those bodies, or whether they might be rather endued with a movement so extremely slow as to have hitherto eluded detection.

To Halley is due the discovery of the important fact that some of the stars have a proper motion. In 1717 he communicated a paper to the Royal Society, in which he showed that a comparison of the places of Sirius, Arcturus, and Aldebaran, as determined by Hipparchus about the year 130 B. C., with corresponding observations of the same stars made by himself, clearly indicated that during the intermediate interval the stars had sensibly moved southward with respect to the ecliptic, and he obtained a further confirmation of this result by examining the account of an occultation of Aldebaran by the moon, observed at Athens in the year 509 A.D.

A few years after Halley announced this important fact, Bradley made his famous discovery of the aberration of light, and its effect upon the apparent place of a star; and subsequently the same astronomer discovered the apparent sidereal movement depending on the nutation of the earth's axis. The astronomer could now ascertain the true place of a star in the heavens with a precision to which the results of previous efforts could offer no comparison, and it seemed probable that ere long the great problem of the proper motions of the stars might be attacked with some hope of success.

To ascertain the proper motion of a star it is necessary to have two well-determined places of the star separated from each other by a sufficiently great interval of time. Down to the middle of the last century no such materials may be said to have existed, if we except a few isolated cases, such as those referred to by Halley, for the probable errors in the observed places of a star far exceed in magnitude the minute quantity which was the object of inquiry. To Bradley is due a great work of observational astronomy which has constituted the basis of the more extensive investigations of the present day relating to the proper motions of the stars. This consisted in a series of star observations executed by that astronomer at the Royal Observatory, Greenwich, from 1750 to 1762, but which it was reserved for Bessel, the great German astronomer, to reduce, and finally to publish in the year 1818. A comparison of those star places with the corresponding results obtained at Greenwich Observatory in the present century by Sir George Airy, the late Astronomer Royal, has conducted astronomers to important conclusions respecting the proper motions of the stars. Materials tending to elucidate the same great question have also been derived from the star observations of several other astronomers of the present century.

[The lecturer here exhibited a diagram containing the following illustrations of the proper motions of the stars:

Star.	Magnitude.	Proper Motion in a Thousand Years. Seconds.
Sirius	1	1,360
Procyon	1	1,210
Arcturus	1	2,230
α Centauri	1	3,710
Capella	1	250
Rigel	1	20
Antares	1	30
Groombridge 1830	7	7,106
61 Cygni	6	3,200
O^2 Eridani	4	4,100
Lalande, 27,744	6	1,681
Lalande, 30,044	7	1,607
Lalande, 30,694	6	1,789
Weisse's Bessel XVII., 322	7	1,476]

The last four proper motions have been recently detected at the Glasgow Observatory, where a system of star-observing has been prosecuted since the year 1860.

It must strike every one who inspects the foregoing list that the proper motion of a star has no relation whatever to the apparent magnitude of the star. Thus Rigel, one of the most brilliant stars in the heavens, has a proper motion of only 20 sec. in a thousand years. On the other hand the star 1830 Groombridge, which has a proper motion of 7,106 sec. in a thousand years, is a star of only the seventh magnitude. The same remark obviously applies to the other stars in the list. And yet one would have thought that the brighter stars, being presumably nearer to us than the fainter stars, would for that reason have a larger proper motion. With respect to α Centauri and 61 Cygni, which we know, from the researches of astronomers on their parallax, to be the two nearest stars, it turns out conformably to what one might expect, that they have also large proper motions; but what are we to think of 1830 Groombridge, which, although a star of only the seventh magnitude, and one which hardly indicates any sensible parallax, exhibits notwithstanding the largest proper motion of any star in the heavens? These anomalies are doubtless attributable to differences in the absolute magnitude and intrinsic splendor of the stars, and furthermore to the fact that the proper motions as revealed by the telescope are only the motions which are resolved at right angles to the line of sight.

Heretofore the proper motion of a star has been found to take place constantly in the same direction, and, as the angular amount of proper motion is in all cases exceedingly small, the same result will probably continue to manifest itself for ages to come. The mean apparent diameter of the sun amounts to 1,944 sec., consequently Arcturus would require nearly a thousand years to describe, in virtue of his proper motion, an arc of a great circle of the celestial sphere, equal to the mean apparent diameter of the sun.

* Abstract of lecture delivered at the Royal Institution.

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